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No. **8**

compiled by
G.D. Hobson and J. Voyce

1989

Étude du plateau continental polaire

Titres et résumés des articles scientifiques publiés grâce au soutien de l'ÉPCP

N° **8**

compilé par
G.D. Hobson et J. Voyce

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PREFACE

PCSP is pleased to present a compilation of publications arising from fieldwork supported by PCSP over the past four years. This bibliography is a good indication of the level, quality and significance of research activities taking place in the Canadian Arctic.

In 1958, at the time of its inception, PCSP restricted its activities to the polar continental shelf; today, PCSP's expertise encompasses most of Canada's High Arctic. Its clientele has increased tremendously to include territorial, provincial and university agencies. During the 1988 field season alone, approximately 1100 scientists passed through PCSP base camps. Over the past 30 years, PCSP has offered its services to over 12,000 scientists and researchers throughout the Arctic Islands, the Arctic Ocean, and the adjacent continental shelf. The 1988 and 1989 field seasons are important, as PCSP will move into new facilities at Resolute and Tuktoyaktuk. These facilities will enable PCSP to further enhance the level and quality of services to its clientele.

PCSP wishes all of you the very best in your Arctic fieldwork.

February 24, 1989

PRÉFACE

L'Étude du plateau continental polaire (ÉPCP) est heureuse de vous faire parvenir la bibliographie des ouvrages qui ont été publiés en partie grâce au soutien logistique de l'ÉPCP. Cette bibliographie démontre sans équivoque la qualité, la pertinence et la vigueur de la recherche arctique.

Lors de sa fondation en 1958, l'ÉPCP menait ses opérations exclusivement dans la région du plateau continental arctique; aujourd'hui son rayon d'action couvre entièrement les îles arctiques, l'océan arctique ainsi que la partie continentale septentrionnale. Sa clientèle est aussi diversifiée, elle comprend maintenant en plus des ministères fédéraux, les agences de recherche universitaires canadiennes et, les ministères et agences de recherche des gouvernements des territories. Ainsi, depuis les trois dernières décennies, l'ÉPCP a offert ses services à plus de 12 000 scientifiques et chercheurs. Les saisons de terrain 1988 et 1989 seront importantes car l'ÉPCP prendra possession de nouveaux édifices autant à Resolute qu'à Tuktoyaktuk. Les nouveaux services qui vous seront offert réponderont je l'espère aux nouveaux défis auxquels vous faites face.

De la part du personnel et de la direction de l'ÉPCP, je vous souhaite une très bonne saison de terrain.

le 24 février, 1989

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ARCHAEOLOGY

2954 ARNOLD, C.D. (1986)

In search of the Thule Pioneers; in Thule Pioneers, eds. E. Bielawski, C. Kobelka and R.R. Janes, Prince of Wales Northern Heritage Centre Occasional Paper No. 2, pp. 1-93.

The Inuit thrive in one of the most austere, demanding and unforgiving environments ever inhabited by man. It is little wonder that they have intrigued the Kabloona ("White Man") ever since the two groups first met in Greenland almost one thousand years ago. Their history is literally frozen in archaeological sites which dot the northern landscape, but only recently have the scientific techniques of archaeology been used to answer questions about where the Inuit came from and how their culture developed.

2955 ARNOLD, C.D., and WOLFE, W. (1986)

Exhibiting "In Search of the Thule Pioneers"; in Thule Pioneers, eds. E. Bielawski, C. Kobelka and R.R. Janes, Prince of Wales Northern Heritage Centre Occasional Paper No. 2, pp. 95-110.

"I found a harpoon head!"
Late in the afternoon Richard had finished the tedious task of removing sod from one of the excavation units and had begun to trowel carefully through the soil beneath. It never seemed to fail that the most interesting finds were towards the end of the day. This was something of a mixed blessing. Finding artifacts usually provided welcome breaks from the monotony of trowelling, but now it meant carefully brushing away soil, photographing the artifact in place, measuring its position and wrapping it up to prevent damage during shipment to the laboratory.

2956 ARNOLD, C.D. (1988)

Vanishing Villages of the Past: Rescue Archaeology in the Mackenzie Delta; The Northern Review; No. 1, pp. 40-58.

The earliest known inhabitants of what is now the Northwest Territories were small bands of people who moved into that land as it emerged from beneath the melting glaciers of the last Ice Age, which drew to a close about 10,000 years ago. From that time on, people expanded into almost every corner of the territory, adjusting the way they lived as needed in order to survive in the young and still changing landscape. The story of who those people were, and how they were able to flourish in some of the most rigorous environments on the face of the earth, today is preserved mainly in archaeological sites.

Unfortunately, large parts of the archaeological record are threatened as forces of man and nature continue to bring about changes in the environment. In an effort to conserve this rich archaeological legacy, the Prince of Wales Northern Heritage Centre established its archaeology programme in 1982. The area we are responsible for is enormous, comprising approximately one-third of Canada, and impressive challenges confront us in our attempts to rescue archaeological sites. Probably nowhere is this more true than in the Mackenzie Delta in the northwest part of the Territories, where archaeological sites are vanishing at an alarmingly rapid rate. With them are going the last traces of a distinctive culture which was extinguished by the wake of an expanding Eurocanadian civilization.

2957 BEATTIE, O. (1985)

Elevated bone lead levels in a crewman from the last Arctic expedition of Sir John Franklin (1845-1848); in The Franklin Era in Canadian Arctic History 1845-1859, ed. Patricia D. Sutherland, National Museum of Man Mercury Series, Archaeological Surv. Can. Paper No. 131, pp. 141-148.

During June and July of 1981, an archaeological survey retraced part of the route of the last Sir John Franklin Arctic Expedition (1845-48). The purpose of the survey was to recover the skeletal remains of crewmen who died after the ice-bound ships were abandoned in the south central Arctic archipelago. Skeletal remains from four individuals associated with the time period of the expedition were discovered. Analysis of these materials, related features, and artifacts indicate that one of the individuals was from the Franklin expedition, while the remaining three were roughly contemporary or earlier Inuit. Earlier search expeditions may have mistaken two of these for Franklin crewmen. Trace element analysis of the remains indicate that the Inuit bones reflect low environmental background lead levels, while the Franklin crewman possesses a skeletal lead level nearly ten times greater. The possibility that absorbed lead played a role during the final months of the disaster should be considered seriously.

2958 BERTULLI, M. (1985)

Northwest Territories Archaeology Field Work in 1985; Prince of Wales Northern Heritage Centre, Archaeology Report No. 2, 32 p.

Some 6000 archaeological sites are scattered across the three and one-half million square kilometers of woodlands, barrengrounds and polar desert that constitute the Northwest Territories. This number probably represents only a fraction of the total number of places where early peoples chose to live as they travelled through this vast territory. Many of these sites, such as those in the Mackenzie Valley and Delta, are threatened by erosion or the activities of development; others in the remote barrengrounds or High Arctic are untouched, with stone tools lying where they were dropped hundreds or thousands of years ago.

By excavating these sites and analysing the materials recovered, archaeologists learn about the people who first inhabited these harsh yet wondrous lands and their ways of life which allowed them to survive and grow. Fortunately, the Northwest Territories Archaeological Sites regulations help to preserve and protect these ancient camps so that we can learn more about the past.

From Devon Island and Roche Bay in the east to the Mackenzie Valley and Delta in the west in 1985, archaeologists have recorded the heritage of the Northwest Territories by excavating sites, searching for undiscovered ones, reconstructing houses of people long since gone, and learning how to make stone tools -- where a hunter's meal begins. Our knowledge of the human past in the Northwest Territories is richer for these efforts.

2959 BERTULLI, M.M. (1985)

Northern Heritage Research Project; Inuktitut, No. 2, pp. 50-53.

For one month each summer for the past seven years, young people from the Northwest Territories have been given a unique opportunity to participate in a scientific research and field school program which stresses the importance and preservation of the cultural and natural heritage of the North. It is called the Northern Heritage Research Project (NHRP). Participants study and assist scientists working on research projects in the disciplines of arctic archaeology, ecology and geography.

2960 BERTULLI, M.M. (1987)

Excavations at QkHn-12 and QkHn-11 Truelove Lowland, Devon Island, High Arctic; Prince of Wales Northern Heritage Centre, internal report, 27 p.

Those portions of QkHn-12 and QkHn-11 excavated in 1984 and 1985 are the remains of Middle Pre-Dorset habitations and activities dating to the mid-second millenium BC. A sample of caribou bone run on a linear accelerator produced a date of 3535+-90 BP (Beta 15389).

A Thule winter house on QkHn-12 was excavated and reconstructed in 1986.

The Pre-Dorset artifact assemblage from the sites is primarily lithic and fairly homogeneous, its small size being its most noticeable characteristic. Table 13 compares the means and standard deviations of burin measurements from the four features excavated at QkHn-12 with the Gull Cliff Component of Port Refuge.

2961 BERTULLI, M., and MONROE, P. (1988)

Northwest Territories Archaeology Field Work in 1987; Prince of Wales Northern Heritage Centre, Archaeology Report No. 4, 33 p.

Archaeology is the study of people who lived in the past. By systematically excavating the old places where people camped and performed their daily activities we learn about ancient cultures and the world around them -- what kind of tools people used, what animals they hunted, and what the climate was like. Archaeology helps us to reach back into the past before there were written records, often to a time that even the old stories and legends have forgotten.

Archaeological sites are important because they are our only direct link to people who lived hundreds and thousands of years ago. Without them our knowledge of the past would be much poorer. For this reason, archaeological sites are protected from any disturbance by a law called the Northwest Territories Archaeological Sites Regulations. Archaeologists must know exactly where each artifact was found within the context of the entire site in order to interpret it fully. Once a site has been disturbed, the one chance we have to record and interpret a site as it was left by its ancient occupants is gone.

Archaeological sites are an important non-renewable heritage resource. If you find a site while out on the land, its location and description should be reported to the Northern Heritage Centre. We need to know about these sites so they can be protected from disturbances associated with development or salvaged if they are threatened by such natural forces as erosion. In the way, archaeological sites and the clues they contain to unlock the past will be available to future generations.

2962 BERTULLI, M.M., and STRAHLENDORF, P.W. (1984)

The Northern Heritage Research Project on Truelove Lowland, Devon Island, High Arctic; Annual Report of the Northern Heritage Society, Northern Heritage Society, internal report, 103 p.

With the completion of the archaeological field research at Stanwell-Fletcher Lake, Somerset Island in 1983, under the principal direction of Dr. E. Bielawski, the Northern Heritage Society (NHS) conducted a search for a new site which would satisfy the combined and equal objectives of advancing the understanding of Arctic pre-history through original research and providing an educational setting for the instruction and science-training of young, native field assistants. Locations in the area of Foxe Basin, which is generally considered to be the core area of Palaeo-Eskimo development, and Cumberland Sound, Baffin Island, were rejected in favour of the propitious invitation from the Arctic Institute of North America to use its research facilities at Truelove Lowland, Devon Island.

Aside from the considerable logistic advantages and the consequent maximization of the NHS's slim financial resources, the Truelove Lowland venue presented the opportunity for liaison with other scientists while in the field and for students and staff of the Northern Heritage Research Project (NHRP) to reap the benefits of the accumulated and diverse knowledge of the camp complement. It was believed that the exposure of the NHRP participants to new ideas and people, and conversely, the

opportunity for the scientists at the research station to observe the project in operation in its cross-cultural atmosphere, would foster learning and understanding on all sides.

2963 HETT, C.E.S. (1985)

Conservation considerations on archaeological sites of the Franklin Era; in The Franklin Era in Canadian Arctic History 1845-1859, ed. P.D. Sutherland, National Museum of Man Mercury Series, Archaeological Surv. Can. Paper No. 131, pp. 185-191.

Concern for the preservation of Arctic sites, and for the artifacts they contain, has become increasingly important as accessibility, resulting in research and tourism, increases in the Canadian north. A review of the conservation measures taken on Dealy Island and Beechey Island shows how the preservation of some sites has been approached, and can indicate some directions for the future. Attention is now given to underwater sites in the north, which introduce new problems of conservation different in both nature and scale from those previously experienced. A close examination of the implications of research undertaken on these sites will be required. A multi-disciplinary approach to both land and underwater sites is seen to be important in meeting the requirements both of archaeology and of preservation.

2964 McCARTNEY, A.P., and SAVELLE, J.M. (1985)

Thule eskimo whaling in the Central Canadian Arctic; Arctic Anthropology; Vol. 22, No. 2, pp. 37-58.

Recent interpretations of prehistoric Thule Eskimo culture of the Canadian Arctic emphasize whaling as well as nonwhaling subsistence patterns, depending upon location and period. Mathiassen was the first archaeologist to contrast the whaling pattern with the nonwhaling pattern of caribou/seal hunting and fishing. The Somerset Island-Boothia Peninsula-King William Island area, at the center of the Canadian Archipelago, is an excellent locale for studying these two major adaptations because whaling sites facing open summer waters are found near nonwhaling sites facing ice-choked channels. Whale bones occur in abundance at Thule winter sites between Creswell Bay and Bellot Strait on Somerset Island; much of the beach there is postulated to have been used by Thule Eskimos as a whaling beach. Boothia Peninsula and King William Island sites, by comparison, have very few whale bones, but are situated near caribou crossings and/or sealing localities and rivers and lakes rich in fish. By contrasting these two dominant subsistence-settlement systems, the variability of the Thule archaeological record may be clarified in regard to local and regional ecological adjustments. Methodologically, we note that combined aerial and foot surveys have proved to be important in locating sites and associated subsistence activity areas such as whaling beaches.

2965 McCULLOUGH, K.M. (1986)

Review of Thule Pioneers, eds. E. Bielawski, C. Kobelka, and R.R. Janes, Prince of Wales Heritage Centre Occasional Paper No. 2, Arctic, Vol. 39, No. 4, pp. 372-373.

2966 McCULLOUGH, K.M. (1988)

Neo-Eskimo diet and hunting strategies on eastern Ellesmere Island, Northwest Territories, Canada; in Proc. 19th Annual Conference, Archaeological Assoc., Univ. Calgary; Diet and Subsistence: current archaeological perspectives; eds. B.V. Kennedy and G.M. LeMoine, pp. 190-206.

A major objective of the Ellesmere Island Research Project was to reassess the chronological position and cultural relationships of the enigmatic Ruin Island phase of early Thule culture in the eastern High Arctic. This objective was achieved through the analysis of data from several Ruin Island-related winter house ruins in the Bache Peninsula region of eastern Ellesmere Island, Northwest Territories. Our research has shown that the Ruin Island phase represents the initial Thule culture occupation of the Smith Sound region and that this occupation occurred during the late twelfth or early thirteenth centuries A.D. Comparative analysis of house styles and selected artifact traits with Alaskan Neo-Eskimo cultures indicated that the phase was most closely affiliated with Punuk-influenced, early Western Thule sites in Western Alaska, suggesting that the latter area, rather than North Alaska, was the probable source area for the Ruin Island phase.

2967 McGHEE, R. (1974)

The peopling of arctic North America; in Arctic and Alpine Environments, Chapter 15: Archaeology, Section A, eds. J.D. Ives and R.G. Barry, Methuen, London, England; pp. 831-855.

The immediate ancestors of man developed their biological capacities in the warm low-latitude forests of the Late Tertiary era. The subsequent history of human development has seen a series of dispersals into the temperate and cooler regions, as developing cultural capacities supplemented the biological and allowed human populations to adapt to habitats increasingly divergent from their original environmental zone. Aside from insular areas such as Polynesia, the Arctic was the last major region to be occupied by man. In the study of man's development as a cultural animal, the prehistory of the arctic regions is therefore of great interest. In the Arctic, man's biological capacities were clearly insufficient even for simple survival; cultural capacities, especially technological abilities and an accumulated know-

ledge of the environment, were of supreme importance.

The following sections will trace the technological and economic developments which supported the various prehistoric occupations of the North American Arctic. This is an area where human adaptations occurred relatively recently, where the remains of prehistoric settlements are relatively well preserved and therefore accessible to archaeological study, and where populations with a generally Palaeolithic level of technology and economic adaptation continued to live until the time of European contact. Despite these excellent conditions for the reconstruction of prehistory, it must be admitted that our knowledge is still slight, and much more work must be done before we can present an adequate picture of prehistoric developments in the arctic zone.

2968 McGHEE, R. (1974)

The Early Arctic Small Tool Tradition: A Prediction from Arctic Canada; in Inter. Conf. on the Prehistory and Paleoecology of Western North American Arctic and Subarctic, Univ. Calgary Archaeological Assoc. Papers, ed. P. Schledermann, pp. 127-132.

Since the day in 1948 when Louis Giddings discovered the Denbigh Flint Complex, this complex has been generally, if at times vaguely, regarded as the most ancient of known Eskimo cultures. The Arctic Small Tool tradition soon became a handy and apparently meaningful category in which to group the Denbigh and allied complexes in the North American Arctic. Within this tradition, the historical precedence of the Denbigh Flint Complex became associated with the assumption that it represented the earliest known form of the tradition. This assumption was based in part on a series of five rather confusing radiocarbon dates on charcoal in association with the Iyatayet Denbigh material, ranging between 1353 ± 200 B.C. (P-102) and 3111 ± 340 B.C. (C-793). Both of these extreme dates were obtained on a single sample; the remaining three dates on other samples ranged between 1523 ± 200 B.C. (P-103) and 2019 ± 600 B.C. (W-298). Giddings (1964:244-250) chose to accept the earliest radiocarbon date, and to follow Hopkins' analysis of geological and stratigraphic evidence which placed the Denbigh Flint Complex between roughly 2500 and 3000 B.C. This early placement of Denbigh was, at the time, reinforced by a date of 4042 ± 280 B.C. (C-560) from cave 9 at Trail Creek, in vague association with Denbigh-like artifacts. This association has since been questioned by the excavator.

2969 McGHEE, R. (1976)

West Alaskan Influences in Mackenzie Eskimo Culture; in Contributions to Anthropology: the Interior Peoples of Northern Alaska; ed. E.S. Hall, National Museum of Man Mercury Series, Archaeological Surv. Can., Paper No. 49, pp. 177-192.

The Eskimos of the Mackenzie Delta region have received little anthropological attention. Prehistorically a numerous people, with a mid-19th century population estimated at 2500, the combined effects of European disease and massive immigration by Alaskan 'Nunamiut' Eskimos resulted in the destruction of local aboriginal culture by the beginning of the 20th century. The few elements of Mackenzie Eskimo culture which were mentioned by early travellers to the region, notably the large cruciform winter-house and the kayak with upturned bow and stern, were quite distinctive. Lack of information, however, has prohibited a thorough study of the cultural and historical relationships of this group.

In 1969 I began working in the area, with the aim of using the local Thule to Historic sequence as a medium for tracing cultural influences or population movements between North Alaska and the Canadian Arctic over the past 1000 years.

2970 McGHEE, R. (1977)

Ivory for the Sea Woman: The Symbolic Attributes of a Prehistoric Technology; Can. J. Archaeology, Vol. 1, pp. 141-149.

2971 McGHEE, R. (1980)

Archaeological evidence for climatic change during the last 5000 years; in Climate and History: Studies in past climates and their impact on Man; eds. T.M.L. Wigley, M.J. Ingram and G. Farmer, Cambridge Univ. Press, Cambridge, pp. 162-179.

Climatic change is frequently used as an explanation for events in the archaeological record. Events such as abandonment of a region previously occupied, occupation of a region presently uninhabitable, sudden changes in population size, and the introduction of new agricultural crops or techniques, may be related to local environmental changes and ultimately to changes in climate. Yet during the last 5000 years, when climatic variations have been relatively minor and when most human populations were relatively sophisticated both socially and technologically, most such events are as likely to have been the result of social, political or cultural factors. Interpretations of several such events are briefly discussed. It is argued that useful archaeological evidence for climatic change is most likely to come from areas climatically marginal to human occupation, and areas occupied by peoples with relatively simple technologies and economies. Finally, it is suggested that archaeology may usefully contribute to the study of climate by providing other disciplines with information on environmental changes which probably resulted from human activity in various regions over the last 5000 years.

2972 McGHEE, R. (1982)

The Bluefish Caves; Canadian Heritage, No. 38, pp. 8-10.

From a small set of caves overlooking the Yukon's Bluefish River may come evidence of our oldest known archaeological site.

2973 McGHEE, R. (1984)

Frobisher and Franklin Were Here; Canadian Heritage, Vol. 10, Issue 1, pp. 36-40.

Early explorers left some surprising - and poignant - marks upon the north.

2974 McGHEE, R. (1985)

The Ancient Arctic; in The Arctic World, eds. F. Bruemmer and W.E. Taylor Jr., Key Porter Books, Toronto, Canada, pp. 201-208.

2975 McGHEE, R. (1985)

Frozen in Time; Horizon Canada; Vol. 15, pp. 350-355.

Laying down roots in the Arctic, where there were no forests to provide fuel or shelter, posed special challenges. The first inhabitants came long after the rest of the continent was occupied.

2976 McGHEE, R. (1985)

Paleoeskimo occupations of Central and High Arctic Canada; in Memoirs of the Society for American Archaeology, Washington, Vol. 31, pp. 15-39.

MOST OF OUR KNOWLEDGE regarding the Paleoeskimos of Arctic Canada is derived from the "core area" of Paleoeskimo occupation, a rough circle of some 1,000 km diameter including the coasts of Fury and Hecla Strait, Hudson Bay, and Hudson Strait. This is the area in which Dorset culture was first recognized, the source of most of our larger collections, and the area where continuity of development throughout the Paleoeskimo sequence has been demonstrated. The number and size of archaeological collections from this area suggest that it supported a larger Paleoeskimo population than did other regions of Arctic Canada, while the temporal distribution of components and continuities of style suggests that the region was occupied continuously throughout the Paleoeskimo period.

2977 McGHEE, R., and EINARSSON, M. (1983)

Greenlandic Eskimos and Norse: A Parallel Tradition from Greenland and Iceland? FOLK, Vol. 25, pp. 51-61.

During the late tenth century A.D. the Norse expansion across the North Atlantic had reached southwestern Greenland where, by the turn of the millennium, the Norse had established colonies which were to survive for over 400 years. These colonies were located in the modern Julianehaab and Godthaab districts, and summer hunting expeditions regularly visited the Disko Bay region of the central west coast of the island, occasionally penetrating areas farther to the north. Within one or two centuries of the establishment of the Norse colonies, northwestern Greenland began to be settled by Eskimos, who had rapidly expanded their range eastward across Arctic Canada from their Alaskan homeland. Norse historical accounts indicate that the two groups had come into contact by the mid-thirteenth century, while archaeological finds of European material in Eskimo dwelling sites suggest that at least sporadic encounters began to occur as much as a century earlier. The earliest contacts occurred in the areas to the north of the Norse settlements, but by the fourteenth century the Eskimos had moved south to the region of the colonies, and both Europeans and Eskimos seem to have inhabited the area until the disappearance of the Norse at some time during the fifteenth or early sixteenth centuries.

2978 McGHEE, R., and TUCK, J.A. (1985)

Un-dating the Canadian Arctic; in Memoirs of the Society for American Archaeology, Washington, Vol. 31, pp. 6-14.

WHILE THE C-14 METHOD of dating has perhaps been the most important tool ever developed for prehistorians, the results of this technique have not been an unmixed blessing. This is especially true in the far north where wood charcoal, the standard medium for C-14 determinations in most other areas, is only infrequently recovered. Other substances-bone, ivory, blubber, and skin from sea mammals; sod, grass, and peat; bone and antler from terrestrial mammals; and occasionally driftwood or locally available twigs either burned or unaltered - have been submitted for radiocarbon analysis in the hope of unraveling the complex relationships between man and nature in the Arctic through the development of accurate absolute chronologies of events which characterized Eskimo prehistory during the last four or five thousand years.

Most prehistorians engaged in Arctic research have long been aware of gross inconsistencies in the results obtained from C-14 laboratories, and several specialists from these laboratories have offered suggestions for correcting our anomalous results. To date, however, no one seems to have taken the trouble to collect radiocarbon determi-

nations from the Arctic and evaluate them with respect to the known but only partially explained discrepancies between dates obtained on wood charcoal and those obtained on other substances. The following attempt to do so for Arctic Canada and northern Greenland is an indication of what might be accomplished by a less indiscriminate use of radiocarbon dates.

2979 MORRISON, D.A. (1985)

Report on Kugaluk Site Excavations, 1985; Archaeological Surv. Can., National Museum of Man, internal report, 12 p.

Excavations were undertaken in 1985 at Kugaluk, an early historic Mackenzie Inuit site located in Kugaluk Inlet, in the northwestern Northwest Territories. A number of activity areas and structures were mapped and tested, and both faunal and artifact collections were made. The site appears to be an important one from a number of research perspectives, and further work is strongly recommended. Kugaluk is in immediate danger of destruction due to land recession and erosion.

2980 MORRISON, D.A. (1986)

Report on Kugaluk Site Excavations, 1986; Archaeological Surv. Can., Can. Museum of Civilization, internal report, 24 p.

The Kugaluk site (NgTi-1) is located about 110 km east of the mouth of the East Channel of the Mackenzie River, near the northwestern corner of the Mackenzie District, Northwest Territories. The coastal configuration here is dominated by the Tuktoyaktuk Peninsula, which runs approximately east-west, and is defined to the south by the brackish Eskimo Lakes. To the east, these "lakes" communicate with the Beaufort Sea through Liverpool Bay. The Kugaluk site is located on an island near the southern end of a deep inlet at the bottom of Liverpool Bay, called here "Kugaluk Inlet" after the major river flowing into it.

2981 MORRISON, D.A. (1988)

The Kugaluk Site and the Nuvorugmiut: The Archaeology and History of a Nineteenth-Century Mackenzie Inuit Society; Can. Museum of Civilization, Nat. Museums Canada, 116 p.

Kugaluk (NgTi-1) is a small historic Inuit site located near the outlet of the Eskimo Lakes, in the western Canadian Arctic. From its location, it can be attributed to the Nuvorugmiut, one of the five branches or "societies" which comprised the historic Mackenzie Inuit. At contact the largest Inuit group in the Canadian Arctic, the culture and society of the Mackenzie Inuit was almost entirely obliterated over the course of the last century. Poorly distinguished from their neighbours and remote from trading posts on the Peel and Anderson rivers, the Nuvorugmiut receive only scant attention in contemporaneous historic accounts, and in retrospective testimony gathered by Stefansson (1914). What information is available suggests that they engaged in the summer-time hunting of bowhead whales as late as the 1880s, while later accounts focus on intensive caribou hunting at this time of year.

The Kugaluk site comprises three semi-subterranean houses and several outside activity areas, including tool-manufacturing localities, hearths, and a collapsed stage or meat rack. One house was excavated with its adjacent midden, along with the activity areas. A sample of over 45,000 animal bones was collected, and about 1000 artifacts were unearthed. Trade goods and other artifacts present at the site indicate an occupation date between about 1850 and 1875, most probably about 1860. The animal bone proved to be dominated by the remains of caribou, with at least 109 individual animals represented. The analysis of dental eruption patterns and of annular deposition lines in the cementum of caribou teeth suggest a multi-seasonal occupation centered around the August caribou migration.

The excavation and analysis of the Kugaluk site material greatly expands our present understanding of the Nuvorugmiut, and by extension the Mackenzie Inuit in general. Evidently, intensive summer caribou hunting was an important subsistence strategy even in the early contact period, and probably aboriginally as well. Apparently not all Nuvorugmiut followed the same subsistence round, especially during August, when there was a direct scheduling conflict between caribou hunting and bowhead whaling. It is suggested that the Nuvorugmiut, like other Western Eskimo, may have been a ranked or even stratified society, and that pronounced status differences may have accompanied different subsistence choices.

2982 PARK, R.W. (1988)

The Porden Point Thule Project: current problems in Thule Culture research; in Proc. ACUNS National Student Conf. on Northern Studies, eds. W.P. Adams and P.G. Johnson, November 18-19, 1986, Ottawa, Canada, pp. 564-567.

The Thule Culture, the direct genetic and cultural ancestor of the historic Inuit, entered the Canadian Arctic from the west approximately one thousand years ago, and survived until at least the sixteenth century in the High Arctic Islands while developing into the various historic Inuit groups on the mainland and the Low Arctic Islands. During the summers of 1984 and 1985, excavations were carried out at a medium-sized Thule site at Porden Point on the Grinnell Peninsula of Devon Island to investigate several aspects of Thule Culture subsistence and settlement in the High Arctic. In particular, an attempt was made to explore the annual round of the Thule, or at least the coastal portion of it, a goal not previously possible given the fact that only Thule winter

sites have received substantial archaeological investigation.

This paper will outline some of what is known about the subsistence and settlement patterns of the Thule, and also outline some of the gaps in our knowledge. It will draw heavily on the excavation data from the Porden Point site.

2983 PHILLIPS, C. (1985)

The camps, cairns and caches of the Franklin and Franklin search expeditions; in The Franklin Era in Canadian Arctic History 1845-1859, ed. Patricia D. Sutherland, National Museum of Man Mercury Series, Archaeological Surv. Can. Paper No. 131, pp. 149-173.

Between 1976 and 1982, the Arctic Historical Archaeology Project recorded approximately 50 archaeological sites in the High Arctic islands, of which 35 date to the Franklin and Franklin search era. Located on Devon, Beechey, Cornwallis, Somerset, Bathurst, Russell and several smaller islands, the sites include the wintering camps of John Franklin on Beechey Island (1845-46), James Ross at Port Leopold (1848-49), John Ross and William Penny at Assistance Bay (1850-51), Edward Belcher (with Kellett and Pullen) at Mount Beaufort (1852-53), Eden Point (1853-54), Dealy Island (1852-54) and Northumberland House (1852-54), as well as several of the small cairn, depot and sledge camp sites. This paper summarizes the results of the archaeological investigations, and is illustrated with historical prints and photographs of the structural remains and artifacts that have been located.

2984 SAVELLE, J.M. (1984)

Cultural and natural formation processes of a historic Inuit snow dwelling site, Somerset Island, Arctic Canada; American Antiquity, Vol. 49, No. 3, pp. 508-524.

Analysis of the remains of a historic Inuit winter site, in conjunction with information supplied by one of the original inhabitants, demonstrates that despite post-occupational disturbance in the form of snow melt and associated downslope movement, the original internal site structure was maintained. Specific activity loci are identified for two snow houses, one occupied during early winter and the other during late winter. Changes in artifact and faunal element characteristics associated with the two dwellings are shown to reflect adjustments in various hunting and domestic activities from early to late winter.

2985 SAVELLE, J.M. (1985)

Effects of nineteenth century European exploration on the development of the Netsilik Inuit culture; in The Franklin Era in Canadian Arctic History 1845-1859, ed. Patricia D. Sutherland, National Museum of Man Mercury Series, Archaeological Surv. Can. Paper No. 131, pp. 192-214.

Nineteenth century European exploration in the Boothia Peninsula-King William Island-Adelaide Peninsula region resulted in little sustained direct contact with indigenous Netsilik Inuit, and the impact of direct explorer/Inuit interaction on cultural development was relatively minor. The abandonment of the Victory and associated materials in Lord Mayor Bay in 1832 by John Ross, and the abandonment of the Erebus and Terror and associated materials in the King William Island region by surviving members of the Sir John Franklin expedition in 1848, however, introduced vast quantities of potentially salvable rare and exotic materials such as iron, copper, tin and wood. Recent archaeological investigations and museum research designed to determine the nature and extent of the post-abandonment utilization of this material was discussed. While confirming previous reports of substantial utilization, the results, when integrated with relevant data from ethnohistorical literature, also suggest that this utilization resulted in significant changes in intra- and intergroup relationships.

2986 SCHLEDERMANN, P., and McCULLOUGH, K. (1988)

The Ellesmere Island Research Project, Final Report of the 1987 Field Season; Arctic Inst. North America, Univ. Calgary, internal report, 66 p.

The 1987 field research of the Ellesmere Island Research Project was designed with two primary objectives in mind; the first relating to Arctic Small Tool tradition (ASTt) occupations in the Bache Peninsula region of eastern Ellesmere Island and the second focussing on prehistoric settlements in the Goding Bay area to the south. Between 1977 and 1982, extensive archaeological investigations in the Bache Peninsula region had resulted in the discovery of over 250 sites relating to ASTt, Thule culture, and historic period occupations. The analysis of data from over 30 excavated ASTt sites led to the formulation of several specific questions concerning ASTt settlement patterns and the value of using beach ridges as relative chronological indicators during the early ASTt occupation of the Bache Peninsula region. In particular, we wanted to test for contemporaneity between the two main types of ASTt camp features - the slab and boulder constructed axial dwellings located on more sheltered lower beach terraces, and the more amorphous 'scatter' features consisting of poorly defined tent ring outlines or single hearths which were built on exposed upper beach terraces. The possibility that these two types of dwellings could relate respectively to winter and summer occupations by the same group of people would seriously undermine the use of beach ridge chronology in the interpretation of prehistoric sites in the High Arctic. Although most Arctic prehistorians agree that the straight temporal correlation between site location relative to present sea level is too simplistic, few attempts have been made to seriously

investigate this problem. In a similar fashion, the question of camp seasonality remains an unresolved topic which must be studied from a variety of perspectives.

2987 SUTCLIFFE, A.J. (1987)

Processes and rates of decay of mammalian skeletal remains at Canadian High Arctic archaeological sites; Abstract in, Proc. 12th INQUA Congress, Ottawa, Canada, July 31-August 9, 1987.

It has long been recognized by those travelling in the High Arctic that some of the mammalian bones which can be seen lying on the ground, especially those of whales and seals on raised beaches and bones at Inuit archaeological sites, are of considerable antiquity. Hitherto a comprehensive study has been made of their rates and processes of decay and of whether the age of a bone can be estimated from its appearance.

Field studies during 1975 and 1979, by courtesy of Polar Continental Shelf, of dated material on Bathurst and Ellesmere Islands, supplemented by 19th century material received from the 'Investigator' site at Mercy Bay, Banks Island, provide an insight into this problem. It is not possible to generalize about dates of decay, which vary from one microhabitat to another. A bone buried for eleven months of each year under a snow bank will survive longer than one on a wind swept hill top. In a vertical dimension parts of bone buried in the permafrost commonly carry well preserved soft tissues; those in the active layer do not; and those lying on the surface tend to be well preserved with algal growth on their lower surfaces, yet poorly preserved and with moss or lichen above. Ground movements may move a bone from one vertical zone to another.

On the ground surface the decay of the upper part of a bone may precede that of soft parts beneath it. Skulls and bones over a century old commonly carry well preserved horns and inter-vertebral cartilage, which may survive for 300 years; small fragments of bone can survive for at least 3000 years; whale skulls (the oldest evidence available) for 7000 years or longer.

2988 TUCK, J.A., and McGHEE, R. (1984)

Sea Mammal Dates: Science or Science Fiction?; Quarterly Review of Archaeology, Vol. 4, No. 2, pp. 9-10.

This paper by Wendy Hanford Arundale brings to the fore once again the problem of C_{-14} dates obtained from materials other than wood or wood charcoal. This is a problem which is especially acute in arctic regions where wood is often not present but where large quantities of bone, antler, ivory, and even skin, fat, and other tissues are frequently recovered. The discrepancies in dates run on various arctic materials, particularly sea mammal products, has been recognized for about 25 years and several courses of action to deal with these problems have been proposed. Since Arundale's article is largely based on data presented by the present authors (1976) it is necessary to summarize some of the data presented there.

BATHYMETRY

2989 DICKINS, D, MARTIN, L., BJERKELUND, I., POTTER, S., ERICKSON, D., HARPER, J., NORTON, P., JOHNSON, S., and VONK, P. (1987)

Environmental Atlas for Beaufort Sea Oil Spill Response; Env. Can., Environmental Protection Service, Yellowknife and Whitehorse, 235 p.

The primary objective of the atlas is to provide a synthesis of environmental information relevant to the planning and implementation of year-round oil spill countermeasures in both coastal and offshore areas of the Beaufort Sea. The atlas is intended to be used as a link between the environmental characteristics of the region and the practical considerations of providing an effective response to marine oil spills, but not as an oil spill manual. Hopefully this work will lead to better utilization of available resources and to reduced environmental impact in an actual Beaufort Sea spill incident.

This atlas was developed to meet the needs of industry, government, and local community groups for a document specifically related to offshore, year-round oil field development in the Beaufort Sea. Motivation for the project stemmed from the realization in 1983 that none of the existing manuals and atlases related to oil spill response addressed the question of year round sensitivity of both coastal and offshore areas to oil spills in ice and open water.

The emphasis throughout the atlas is on the presentation of selected information in a concise, graphic form with important supporting text. The selection of information is intended to satisfy a wide variety of perceived user groups.

The current atlas represents a completely new information base, which is organized, mapped, and presented entirely as a computer-generated product. The atlas can be updated at any time by entering new information to replace or augment the existing files.

The atlas is useful in three major areas: first to assist in the development of the most effective contingency plans for a specific area; second to provide a source document on which to base realistic oil spill training exercises; and third to act as a basic field reference to important environmental factors in an actual spill situation. Information contained in the atlas must be supple-

mented by local knowledge and real time information in the event of a spill.

The study area covers the southern Canadian Beaufort Sea from the United States/Canada border on the west to Baillie Islands on the east. The actual coastline exceeds 2,700 km in length while the direct east-west distance across the study area is only 520 km (>5/10 old ice). The northerly extent of the study area is based on the median location of the polar pack edge. The southern boundary of the area is determined by the backshore limits of potential contamination from a marine oil spill. These limits are defined as the maximum area of inundation which could occur during positive storm surge events (onshore winds).

2990 JACKSON, H.R., MUDIE, P.J., and BLASCO, S.M. (1985)

Initial geological report on CESAR - the Canadian Expedition to study the Alpha Ridge, Arctic Ocean; Geol. Surv. Can., Paper 84-22, 177 p.

This volume describes geological material obtained on the Canadian Expedition to Study the Alpha Ridge, abbreviated as CESAR. The Alpha Ridge is one of the Arctic Ocean's major features, and is particularly interesting to Canadians because it terminates on the North American side of the ocean off the continental shelf northwest of Ellesmere Island. The ridge takes its name from Ice Station Alpha, which drifted over it. This ice station was one of the two scientific camps in the Arctic established by the U.S. Air Force, in its project Skate, as a contribution to the Arctic Ocean Study Program of the International Geophysical Year of 1957-1958. Alpha Ridge was known before this from observations made during the drift of the U.S.S.R. Ice Station NP-4, and from soundings made by the High Latitude Aerial Expeditions of the U.S.S.R.

Good ideas come from individuals, not bureaucracies. J.R. Weber, J.F. Sweeney and A.S. Judge of the Earth Physics Branch proposed the expedition to celebrate the centenary of the First International Polar Year of 1882-1883. Good ideas also get followers. Eventually on the ice, staff congregated from a whole host of organizations: Earth Physics Branch, Geological Survey of Canada (Atlantic Geoscience Centre and Resource Geophysics and Geochemistry Division), Canadian Hydrographic Service, Atlantic Oceanographic Laboratory, Marine Ecology Laboratory; Universities - Dalhousie, Washington, Miami, Columbia (Lamont-Doherty), and Wisconsin. The logistics support was provided by the Polar Continental Shelf Project and the Department of National Defence.

Ice camp CESAR was established on the drifting sea ice and from it a variety of experiments were conducted from 31 March and 23 May (day 90 to 143) of 1983. This report is concerned with the experiments and observations relating to the geology, bathymetry, seismic reflection, bedrock, and sediment samples collected from the ice camp. The principal goal of the sampling programs was to collect data to improve the knowledge and understanding of the Alpha Ridge. Core material that provided constraints on the origin and the history of the ridge would be used for this. If the samples were not destroyed while recovering this information, or if insufficient material was available, it would be used to clarify questions on the sedimentary history and paleoenvironment of the Arctic Ocean. To enable the achievement of these goals a piston coring facility was erected at the main camp and gravity cores were collected at the main camp and at two remote camp sites.

2991 JACKSON, H.R. (1985)

Knowledge of the Alpha Ridge prior to CESAR; in Geol. Surv. Canada Paper 84-22, pp. 11-14. CESAR Contr. No. 8.

Bathymetric data, geological samples and geophysical information collected prior to CESAR are reviewed. This material provides a framework in which the CESAR data set can be interpreted.

2992 LAPOINTE, M.F. (1986)

Deep scour holes on the bed of Mackenzie Delta channels, NWT; Env. Can., Nat. Hydrology Res. Inst., internal report, 36 p.

The study of unusual bathymetric features in Mackenzie Delta channels, of relevance to eventual pipeline crossings, has been pursued in 1985-86. In particular, the shape, location and distribution of deep "scour holes", some attaining 5 to 6 times the average bankfull channel depth, have been better documented and detailed flow studies have been conducted near these features to clarify their origin. Growing evidence points to complex hydraulic and boundary material controls involved in the creation and evolution of these bathymetric "anomalies". Most such holes are located near bend apices, where hydraulic forces may be suited to preventing settling of suspended fine sands and silts, and possibly evacuating loose muds from the bed. However, many tight bends do not display unusual depths and deep holes also occur on straight or quite gently curved reaches, where little concentration of hydraulic forces is expected. Moreover, there is independent evidence that spatial inhomogeneities in erodability of delta plain materials can, by themselves, affect channel form and shifting patterns in the Mackenzie Delta. Such inhomogeneities could be caused by differences in texture, degree of consolidation, segregated-ice content, etc. It is hypothesized that such differences play a large role in shaping some of the unusual bathymetric features studied. To progress further in understanding the origin of the scour holes, more information is needed on the exact nature and spatial patterns of such inhomogeneities.

2993 MacLEAN, B. (1986)

CSS HUDSON Cruise 86-027; Geol. Surv. Can. Atlantic Geoscience Centre Cruise Report, 36 p.

Cruise 86-027 was carried out from CSS Hudson and commenced at Resolute Bay on August 25 and ended at Deception Bay, Quebec, on September 26, 1986. Objectives were to collect geological, geophysical, geotechnical, biological, physical, physical oceanographic, and hydrographic data.

2994 SOBCZAK, L.W., and WEBER, J.R. (1987)

Gravity and bathymetry taken along seismic refraction lines from the Canadian Ice Island during 1985 and 1986; in Current Research, Part A, Geol. Surv. Can., Paper 87-1A, pp. 299-304. Ice Island Contr. No. 10.

As part of the Frontier Geoscience Program a combined gravity-bathymetry survey along four seismic refraction lines was carried out during the spring of 1985 and 1986 from the Canadian Ice Island base camp located on the Arctic Ocean about 30 to 40 km northwest of Axel Heiberg Island, N.W.T. A total of 140 gravity observations and 124 water depth measurements were made along two lines parallel, and two lines perpendicular to the coastline of the Queen Elizabeth Islands.

Water depth measurements from these surveys combined with previous data indicate two hitherto unmapped ridges and valleys striking perpendicular to the trend of the Queen Elizabeth Shelf.

Gravity measurements indicate an elongated coastal Bouguer anomaly "high", subparallel to the coast-line, with accompanying landward trending spurs. These anomalies overlie the northeastern end of the Sverdrup Rim at the northwestern end of Ellesmere Island where the Bourne Complex and Unnamed Formation, consisting of volcanic basalt flows with dense mafic intrusions, are exposed.

2995 VAN WAGONER, N.A., DABORN, G., and MUDIE, P. (1986)

Recent Arctic "Reefs"; Abstract in GAC, MAC, CGU-AGC, AMC, UCG Joint Annual Meeting, Program of Abstracts, Vol. 11, Carleton Univ., Ottawa, Ontario, May 19-21, 1986, p. 140.

During the summer of 1985, a 3 x 7 km^2 and 40 m thick slab of free floating glacial ice, referred to as the Ice Island, was used as a platform for a seafloor sampling program of the Arctic continental margin. The Ice Island drifted at a rate of about 100-500 m/hr. It travelled south from Nansen Sound, contouring bathymetry most of the way, before turning around to the east at about 81°02'N and going back the way it came. Surficial seafloor sampling and observation were accomplished by lowering a dredge, Shipeck grab sampler and bottom camera through a hole in the ice along with continuous high frequency seismic reflection profiling. On average, 2 grab samples, camera stations, and dredge hauls were collected per day during the month of August.

The bathymetric data collected provide the first bathymetric data available for the area covered by the Ice Island. Some of the more interesting bathymetric features are mounds that are 100's of meters wide and have 10's of meters of relief. Dredging across these mounds suggests that they may be biogenic features referred to here as Arctic reefs. These mounds apparently are built of spherical leuconoid sponges up to 25 to 30 cm in diameter and completely covered with a dense 'fur' of siliceous spicules a few cms in length and < 1 mm in diameter. The sponge interior also contains abundant siliceous spicules up to 1 cm in length. These sponges are sometimes host to several other species of sponge and commonly are dotted with delicate bivalve shells usually < 1 cm in size. Few living bivalves were recovered. Dredge recoveries suggest that when these sponges die they degrade leaving a web of spicules that welds the fine sediment. The next younger community of sponges then grows on top of this mat, thus forming the mound. Identification of the invertebrates is in progress.

Both living and dead reefs were recovered. Dead reefs are characterized by layers of siliceous leuconoid sponge spicules, rare other sponges, and bivalve shells which are encrusted with bryozoans and worm tubes and coated with Mn-oxide. Thickness of the Mn-oxide coating may allow dating of the reefs. The living reefs are primarily confined to depths < 150 m.

2996 WEBER, J.R., and COOPER, R.V. (1988)

Crustal structure of the Alpha Ridge and Eastern Canada Basin; Abstract in Joint GAC, MAC, CSPG Annual Meeting May 23-25, 1988, Memorial Univ. of Newfoundland, St. John's, Nfld., Program of Abstracts, Vol. 13, p. A13.

Results from the Canadian Expedition to Study the Alpha Ridge (CESAR) revealed that over the survey area, extending 500 km from the Makarov Basin across almost the entire width of the ridge, the Alpha Ridge to be an up to some 40 km thick structure with unusually homogeneous density, seismic and magnetic properties. It has been speculated previously that the structure may consist of mafic rock created by the passage of a hot spot associated with plume activity. It is now proposed that the submarine ridges and valleys that parallel the ridge axis may reflect block-faulting developed early when the lithosphere was too weak to support the massive accumulation of volcanic rock. Block-faulting probably ceased during Early Cretaceous after the lithosphere cooled and thickened.

In the spring of 1987 the Canadian Hydrographic Service carried out a reconnaissance bathymetric and gravity survey between the polar continental

shelf and the CESAR survey, thus providing coverage of the eastern end of the Canada Basin and the south flank of the Alpha Ridge. A crustal transect across the entire region along the 109 W meridian is presented.

2997 WEBER, J.R., and HALLIDAY, D.W. (1984)

Bathymetry and gravity of the Alpha Ridge; Abstract in Proc. Can. Geophys. Union, 11th Annual Meeting, Dalhousie Univ., Halifax, N.S., May 29-June 1, 1984, pp. 83-84.

In cooperation with the Canadian Hydrographic Service some 1300 individual depth soundings and gravity measurements were established over the Ellesmere Island Continental Shelf and Alpha Ridge to the 116°W meridian. In addition, some 120 line kilometres of echo sounder and gravity recordings were established along the drift track of the CESAR station. A 100-m contour bathymetric map and a 10-mGal contour free-air gravity anomaly map were compiled which include data collected from Ice Island T-3 between 1969 and 1974. Unlike the Lomonosov Ridge the bottom topography is very complex and rugged. The minimum depth recorded over the Alpha Ridge is 1087 m. The ridge joins the Continental Shelf at a depth of between 1800 and 2000 m. Generally, the free-air anomalies mirror the ridge topography. Over this portion of the Continental Shelf the gravity map shows the same sort of positive elliptical free-air anomalies that have been discovered all along the Canadian and Alaskan Continental Shelf and that are indicative of the transition between continental and oceanic crust.

2998 WEBER, J.R., and JACKSON, H.R. (1985)

CESAR bathymetry; Geol. Surv. Canada, Paper 84-22, pp. 15-17. CESAR Contr. No. 9.

The bathymetric data collected during CESAR are reported along with the navigation control for main and remote camps and the spot soundings. The major topographic low between the north and south ridge crests is called a graben.

2999 WEBER, J.R. (1987)

Maps of the Arctic Basin Sea Floor Part II: Bathymetry and Gravity of the Alpha Ridge: The 1983 CESAR Expedition; Arctic, Vol. 40, No. 1, pp. 1-15. CESAR Contr. No. 20.

The general scarcity of geophysical data in the Arctic Ocean Basin and the lack of knowledge about the evolution of the Amerasia Basin and of the nature and origin of the Alpha Ridge led, in 1983, to the undertaking of a multidisciplinary polar expedition, codenamed CESAR 83 for Canadian Expedition to Study the Alpha Ridge. The expedition was supported by the Canadian Armed Forces, first by parachuting 18 airborne engineers onto the CESAR site to build a 1.6 km long airstrip on the pack ice, and then by deploying and two months later evacuating the expedition by military Hercules aircraft. The search for a suitable site on the sea ice was facilitated by a preceding side-looking airborne radar (SLAR) reconnaissance survey of the area.

One of the major CESAR accomplishments was a regional bathymetric and gravity survey over the Ellesmere Island continental shelf and eastern part of the Alpha Ridge. Using the CESAR data as well as all publicly available data collected over the past 35 years, 100 m contour interval bathymetric maps and 5 mGal contour interval gravity free-air anomaly maps were compiled. These extend from the Ellesmere Island coast to the 116°W meridian. The sea floor maps depict the Alpha Ridge as a very broad mountain complex of rugged topography with ridges and valleys trending parallel to the ridge axis. A prominent east-southeast trending valley centered along 86°N latitude between 110° and 125°W longitude was named Cesar Trough and the adjoining ridges Cesar North Ridge and Cesar South Ridge. The Alpha Ridge is separated from the Ellesmere Island continental shelf by a trough 1800-2000 m deep. Over the ridge the free-air anomalies mirror the bathymetry. Elliptically shaped positive anomalies centered over the continental shelf break suggest that the continental margin adjacent to the Alpha Ridge has the typical Atlantic-type structure characteristic of the rest of the North American polar margin. Preliminary interpretation of the gravity field indicates that the Alpha Ridge crust is composed of very thick rocks of laterally uniform density and composition. It is suggested that the eastern part of the Alpha Ridge may be a massive accumulation of mafic rocks of probable oceanic origin formed by volcanic activity.

3000 WELNERS, A. (1986)

Final Field Report, P.C.S.P. survey, Gulf of Boothia, Committee Bay, and Pelly Bay, Proj. File No. 5452-7318; Fisheries and Oceans, Can. Hydrographic Serv., Central Region, internal report, 45 p.

The objective of the 1986 survey program was to collect bathymetric and gravity data in the Gulf of Boothia, in Committee Bay, and in Pelly Bay. Two field sheets, 8256 (Wales Island to Cape Simpson) and 8285 (Pelly Bay) were completed and a third field sheet, 8253, was partially completed. However, due to the shorter than normal survey season, a large portion of Committee Bay remains to be sounded. The survey started on March 21, one month later than usual, due to PCSP budgetary restraints.

BIOLOGY

3001 ADDISON, R.F., ZINCK, M.E., and SMITH, T.G. (1986)

PCBs Have Declined More than DDT-Group Residues in Arctic Ringed Seals (Phoca hispida) between 1972 and 1981; Environ. Sci. & Technol., Vol. 20, No. 3, pp. 253-256.

Mean DDT-group concentrations in the blubber of western Arctic ringed seals (Phoca hispida) sampled in 1981 were less than 1 $\mu g.g^{-1}$ wet weight blubber, and mean PCB concentrations were less than 2 $\mu g.g^{-1}$ wet weight. Male seals had higher concentrations than did females. PCB concentrations were about half of those in a sample of the same population taken in 1972 when allowance was made for the variation of residue concentrations with age, sex, and condition. This decline probably results from the ban on PCB manufacture and use imposed in the early 1970s. Concentrations of DDT-group residues did not show any clear decline over the same interval, and the relative proportions of p,p'-DDT and p,p'-DDE suggested that there is a continuing supply of DDT to the western Arctic. The most probable source of this is by atmospheric or water transport from the Far East, where DDT was used until at least the late 1970s.

3002 ALEXANDER, S.A., and HAWKINGS, J.S. (1988)

Breeding bird survey of coastal islands of the outer Mackenzie Delta and northern Tuktoyaktuk Peninsula, 1987, Env. Can., Can. Wildl. Serv., Tech. Rep. Ser. No. 39, 20 p.

Helicopter surveys for colonial nesting birds on islands along the Canadian southern Beaufort Sea coast were conducted on June 27 and 28, 1987. Ten islands were searched by foot yielding 446 Glaucous Gull nests at 7 islands, 78 Common Eider nests at 8 islands, 5 King Eider nests at one island, 41 Brant nests at 5 islands, plus a few nests of Sabine's Gulls, Arctic Terns and Oldsquaw. Most of the Glaucous Gulls were at three sites: 249 nests at Escape Reef; 101 nests south of Hooper Island; 66 nests at a small island northeast of Hutchison Bay. Thirty-one of the Brant nests were at a second small island northeast of Hutchison Bay. Timing of Glaucous Gull nesting appeared to be more advanced at western colonies than at eastern colonies. Sample sizes for Brant and eiders were not large enough to assess differences in nest initiation throughout the study area. Locations at which no birds or minimal numbers of births were observed are indicated on maps of the study area.

3003 ALEXANDER, S.A., BARRY, T.W., DICKSON, D.L., PRUS, H.D., and SMYTH, K.E. (1988)

Key areas for birds in coastal regions of the Canadian Beaufort Sea; Env. Can., Can. Wildl. Serv., Edm., 146 p.

Information pertaining to avian distribution and abundance along the Canadian Beaufort Sea coast was summarized and used to evaluate the importance of the coastline to birds, in a regional context. Seasonal differences in the requirements of birds were considered through separate evaluations in each of four time-periods: spring migration (May to mid-June), nesting (June to mid-July), molting/broodrearing (mid-July to mid-August), and fall migration (mid-August to late September). The evaluations are presented in a series of ten maps as colour-coded delineations of regions of high, moderate, variable and low avian use. For each region in each time period there is a description of the major aspects of avian use (which may include comments on local population estimates, behaviour, year to year variation in numbers, and local movements of birds), and a listing of some of the data used in the evaluations. A general discussion on the limitations of the data used is presented in the introductory sections as an aid to the interpretation of information contained in the report.

3004 AMSTRUP, S.C., STIRLING, I., and LENTFER, J.W. (1986)

Past and present status of polar bears in Alaska; Wildl. Soc. Bull. No. 14, pp. 241-254.

Polar bears (Ursus maritimus) are distributed throughout most ice-covered seas of the northern hemisphere but occur in low densities. They have a long period of delayed maturation, small litter sizes, and a long reproductive interval. Polar bears compensate for low productivity with long life-spans.

Recent and future events in arctic regions may disrupt the survival strategy of polar bears. The discovery of the world's tenth largest oil field at Prudhoe Bay, land disposals resulting from the Alaska Native Claims Settlement Act of 1971, which was spawned by that discovery, and concomitant increases in wealth have resulted in dramatic changes in populations of humans in Alaska's arctic. Human numbers in the Arctic Slope Region increased 57% during 1960-1980, 23% during 1980-1983, and continue to rise. With the establishment of new villages, people also live in previously uninhabited locations. Up to 40% of the remaining oil and gas in the United States may be in this region, and most of that is in offshore areas. Consequently, growth in human numbers and activities in polar bear habitat will continue.

3005 ARNER, B.D., DICKSON, D.L., and VERREAULT, G. (1985)

Bird observations from Atkinson Point, Northwest Territories, 1984; Env. Can., Can. Wildl. Serv., 37 p.

While studying red-throated loons in June 1984, additional information was collected on other bird species at Atkinson Point, NWT. Coastal areas of

the Beaufort Sea are known to support staging, feeding and breeding habitat for many species of water birds. The coastal areas are also active centres for hydrocarbon exploration.

Daily totals were kept for all bird species observed. Nesting information was gathered on species, location, clutch size, and nest site description. Weather data and the timing of melt of ice and snow were also recorded.

Fifty species of birds were observed, of which nests were found for 20 and another eight were suspected of breeding. Known breeding ranges of tree swallow, (Tachycineta bicolor) and barn swallow (Hirundo rustica), were extended. A northern-most sighting of common merganser (Mergus merganser) was also recorded. There were eight new breeding records and five new sightings for Atkinson Point.

The most common nesting species were red-throated loon (Gavia stellata), brant (Branta bernicla), glaucous gull (Larus hyperboreus) and lapland longspur (Calcarius lapponicus). Nesting water birds were found in higher densities in drained lake basins than in other wetland tundra habitats.

3006 BARRY, T.W. (1986)

Eiders of the western Canadian Arctic; in Eider ducks in Canada, ed. Austin Reed, Env. Can., Can. Wildl. Serv., Rep. Ser. No. 47, pp. 74-80.

The only eiders that nest regularly in the western Canadian Arctic are the King Eider (Somateria spectabilis), and the Pacific race of the Common Eider (S. mollissima v. nigra). The King Eider, which nests near inland lakes and ponds, is abundant and widely distributed. The Pacific Eider, being restricted to those marine habitats that become ice-free early in spring, is less numerous and distributed irregularly. Because of lengthy and extended spring, fall, and moult migrations between the Canadian Arctic and the Chukchi Sea, there is a continual movement of eiders across the Beaufort Sea from April to early November.

3007 BATES, S.S., and COTA, G.F. (1986)

Fluorescence induction and photosynthetic responses of Arctic ice algae to sample treatment and salinity; J. Phycol., Vol. 22, pp. 421-429.

The measurement of photosynthetic rates of algae growing on the undersurface of 1.7 m thick ice in the Canadian Arctic (Resolute Passage, N.W.T.) presents several problems. During the preparation of samples for physiological measurements, the ice algae may be exposed to salinity and temperature shocks. Fluorescence induction (the rise in in vivo Chl a fluorescence intensity during a period of milliseconds) and photosynthesis-irradiance (PI) experiments examined the potential effects of salinity and temperature on the physiology of ice algae.

Experimental suspensions were routinely prepared by scraping one part ice crystals (11-14°/oo salinity) and attached algae from the bottom ice into four parts filtered seawater (32°/oo salinity) giving a final salinity of 28-31°/oo. Post-dilution of melted ice scrapings with seawater suppressed photosynthetic ^{14}C-fixation and decreased A_{DCMU} (the area above the fluorescence induction curve measured in the presence of the inhibitor DCMU; an estimate of photosynthetic capacity) by a factor of 3-16, due to the low salinity of the melted ice scrapings. Fluorescence induction and PI experiments showed that the ice algae had a salinity optimum near 30°/oo, close to the ambient seawater salinity. Experiments in which the Chl a concentration was manipulated showed that $A_{DCMU}\ P^B_m$ (Chl a-normalized rate of photosynthesis at light saturation), and a (photosynthetic efficiency) declined with increasing Chl a concentration. Ice algae tolerated heating (1.5°C•min^{-1}) up to 17°C, above which A_{DCMU} decreased with sample temperature.

3008 BIRKHEAD, T.R., and NETTLESHIP, D.N. (1984)

Egg size, composition and offspring quality in some Alcidae (Aves: Charadriiformes); J. Zool. Lond., Vol. 202, pp. 177-194.

The composition of fresh and fully developed (pipping) eggs of four alcids, Razorbill, Common guillemot, Brünnich's guillemot and Atlantic puffin was examined. There were no differences in egg composition between the semi-precocial Atlantic puffin and the three species with "intermediate" developmental patterns. The absolute amount of yolk increased with egg size in fresh eggs, and the relative amount remained constant with egg size for Common guillemot and Razorbill, but decreased in the Atlantic puffin. In fully developed eggs chick weight and egg weight were closely correlated, and this was due mainly to larger eggs producing chicks with larger yolk reserves. Under some conditions chicks from larger eggs do better than those from smaller eggs. Several factors influence egg size; a comparison of first and replacement eggs laid by the same females showed that a maternal effect accounted for 60-90% of the variance in egg-size and that laying date accounted for most of the remaining variance.

3009 BIRKHEAD, T.R., GREENE, E., BIGGINS, J.D., and NETTLESHIP, D.N. (1985)

Breeding site characteristics and breeding success in Thick-billed Murres; Can. J. Zool., Vol. 63, pp. 1880-1884.

Breeding site characteristics of Thick-billed Murres, Uria lomvia, differed significantly between Cape Hay, Bylot Island, and Coburg Island, N.W.T., Canada. Logistic regression analysis

showed that at both colonies site characteristics had significant effects on breeding success. At Coburg Island the slope and width of the ledge were the most important factors, whereas at Cape Hay the number of walls and neighbours, and to a lesser extent the width of the ledge, best explained the variation observed in breeding success. Egg and chick mortality factors differed at each colony. At Coburg Island most eggs were lost through accidentally rolling off ledges, and at this colony birds on level sites on broad ledges were most successful. At Cape Hay most mortality of eggs and chicks occurred as a result of rock- and ice-falls; sites offering some protection were the most productive. Comparisons are made with other studies, and the role of breeding site quality in population regulation is discussed.

3010 BIRKHEAD, T.R., and NETTLESHIP, D.N. (1985)

Plumage variation in young Razorbills and Murres; J. Field Ornithol., Vol. 56, No. 3, pp. 246-250.

Variation in the head, chin, and throat plumage of young Thick-billed Murres (Uria lomvia) and Razorbills (Alca torda) has been reported by Gaston and Nettleship (1981) and Hudson (1984), respectively. These authors found that young, just prior to leaving the colony, were of one of two plumage types, having: (1) a dark head, cheeks, chin, and throat, referred to as "summer" plumage because it resembles the adult summer plumage; or (2) white cheeks, chin, and throat, similar to the adult winter plumage and referred to as "winter" plumage. We present data on the occurrence of this and other plumage variation among Razorbills, Common Murres (U. aalge), and Thick-billed Murres.

3011 BIRT, V.L., and CAIRNS, D.K. (1987)

Kleptoparasitic interactions of Arctic Skuas Stercorarius parasiticus and Black Guillemots Cepphus grylle in northeastern Hudson Bay, Canada, IBIS, Vol. 129, pp. 190-196.

Kleptoparasitic behaviour of Arctic Skuas was studied at a Black Guillemot colony in northeastern Hudson Bay, Canada. Skuas procured fish in 7•2% and 19•9% of attacks, and Black Guillemots lost fish in 7 2% and 21•2% of chases in 1982 and 1983, respectively. In 1983 chase outcome was related to distance between birds at the end of a chase and number of skuas in pursuit. The skuas' foraging efficiency (energy intake/energy expended during hunting) was estimated at 4•5 for 1982 and 5•8 for 1983, and total daily energy expenditure was estimated at 2•4 and 2•1 x b.m.r. for these years. Energetic calculations suggested that skuas obtained sufficient food to meet their daily needs in 3•6 h of hunting in 1982 and 2•7 h in 1983. The absence of intensive kleptoparasitic activity by breeding skuas in North America is attributed to the paucity of colonies suitable for both feeding (due to available host species and colony topography) and nesting (due to presence of arctic foxes and/or polar bears).

3012 BROMLEY, R.G., and McLEAN, B.D. (1986)

Raptor surveys in the Kitikmeot and Baffin Regions, Northwest Territories, 1983 and 1984; Govt. N.W.T., Renewable Resources, Wildl. Serv., Yellowknife, File Report No. 65, 63 p.

Raptor surveys initiated in 1982 were continued and expanded in the Kitikmeot and Baffin regions in 1983 and 1984. Surveys were specifically designed for investigating gyrfalcon densities, productivity and production. Those censuses conducted by snow-machine during the spring covered 1,350 km^2 in 1983 and 6,540 km^2 and 3,650 km of coastline in 1984. Aerial surveys by helicopter covered 17,522 km^2 and 14,951 km^2 in 1983 and 1984, respectively. Spring phenology was about 10 days advanced in 1984 over 1983 and 1982. Density of territorial pairs was quite low in 1983 (1 pair per 604 km^2), particularly in the Baffin Region survey areas (1 pair per 1,333 km^2), compared to 1984 (1 pair per 253 km^2 overall, 1 pair per 233 km^2 in Baffin). Productivity of territorial pairs was stable, but total production of young was 62% higher in 1984 (55 young) than in 1983 (34 young) for those areas surveyed both years.

A comparison of estimates of productivity based upon spring and summer surveys, versus summer surveys only was made. The comparison indicated that if only summer surveys (July) were conducted, the rate of productivity of gyrfalcons could be overestimated by 50%. Two surveys are thus required to estimate productivity of territorial pairs; one during incubation and one during the nestling period. The incubation survey can be used to estimate population sizes, and the nestling survey can yield production information.

Reoccupancy rates of territorial gyrfalcons were high, indicating a high degree of traditional use of territories. This can be important in designing long-term monitoring studies of the species.

Density of territories of Peregrine Falcons varied from 1 per 278 km^2 in 1983 to 1 per 156 km^2 in 1984. As with Gyrfalcons, the increased density may have been partly in response to early spring phenology. Productivity of peregrines averaged 2.8 and 3.0 eggs and/or young per pair in 1983 and 1984, respectively. Since peregrines initiate nests much later than Gyrfalcons, productivity measurements were made much earlier in their nesting chronology than for Gyrfalcons.

Data on production and reoccupany rates are presented for Common Ravens and Golden Eagles. Nesting observations of Rough-legged Hawks, which rose to a population peak in 1984, are also presented.

3013 BROWN, R.G.B., and NETTLESHIP, D.N. (1984)

The seabirds of northeastern North America: their present status and conservation requirements; Inter. Council for Bird Preservation, Tech. Pub. No. 2, pp. 85-100.

The breeding distributions and populations of the main seabird species along the coasts of northeastern North America from the Gulf of Maine north to Ellesmere Island are summarized. The total population exceeds four million breeding pairs, with the majority in the eastern Canadian Arctic. The largest population is in the Newfoundland-Labrador region which contains 97 percent of the Common Murre population of eastern North America and 92 percent and 99 percent of the North American populations of Razorbill and Atlantic Puffin respectively. Overall, the Arctic colonies are few in number but are large in size (30 percent of the 23 colonies contain more than 100,000 pairs), whereas colonies from Labrador southwards are numerous, contain many species, and are small (80 percent of the 150 colonies contain fewer than 1000 pairs).

The best estimates of the present status of the major colonial species breeding in this region indicate an increase in numbers and expansion of range of Northern Fulmar, Great Black-backed Gull, Herring Gull and Black-legged Kittiwake in temperate regions, and a general tendency for a decrease in numbers of the remaining colonial species (Leach's Storm Petrel; Northern Gannet; Great and Double-crested Cormorants; Common, Arctic and Roseate Terns; Razorbills; Atlantic Puffins; Thick-billed Murres, and Common Murres (except in Newfoundland-Labrador)). Commerical fishing, chemical pollution, hunting, gill-net drowning, gull predation, and disturbance at the colonies seem likely to be prime causes of the declines observed.

The present conservation needs of seabirds in northeastern North America are reviewed and out-lined.

3014 BUTLER, J.E. (1985)

Phytoplankton ecology in a High Arctic polynya; unpub. M.Sc. thesis, Civil Engineering Dept., Univ. British Columbia, 105 p.

Primary production was studied in Fram Sound, part of the Hell Gate-Cardigan Strait polynya, from June to August, 1982. Primary production rates, phyto-plankton biomass (chlorophyll a), and water transparency were measured and used in conjunction with modelled solar radiation values to numerically model primary production during this time. The major phytoplankton nutrients were also measured.

Early season chlorophyll a concentrations were low, and the increased light availability due to reduced ice cover in this area did not appear to enhance early season production. Chlorophyll concentrations peaked twice; the first peak occurred on 20 July and the second on 14 August. The mean primary production rate and phytoplankton biomass were 998 mg $C.m^{-2}.d^{-1}$ and 72 mg $chl.m^{-2}$. This production rate is higher than that measured in other High Arctic areas.

Nitrogen, phosphorus and silica were essentially homogeneously distributed during the sampling period and these concentrations varied little from June to August except during 5 days in late August, when they decreased by half then returned to previous levels.

3015 CAIRNS, D.K. (1987)

Diet and foraging ecology of Black Guillemots in northeastern Hudson Bay; Can. J. Zool., Vol. 65, pp. 1257-1263.

I examined diet and foraging habitat selected by Black Guillemots (Cepphus grylle) in the eastern Canadian arctic. Birds fed on fish (Boreogadus saida, Stichaeus punctatus, Eumesogrammus praecisus) and mysid, amphipod, and decapod crustaceans. Guillemots concentrated at landfast ice edges early in the breeding season. Open-water foraging occurred principally in waters 10-30 m deep within 13 km of breeding colonies. Guillemots were aggregated on the water, but their distributions were not correlated with those of schooling prey. Guillemots feeding in open water obtained much of their food on the bottom, but some prey was likely taken during transit to and from the bottom.

3016 CAIRNS, D.K., BREDIN, K.A., and BIRT, V.L. (1987)

A tunnel for hidden access to blinds at high latitude seabird colonies; J. Field Ornithol., Vol. 58, No. 1, pp. 69-72.

We describe a tunnel made with wooden supports connected by ropes and covered with light, but waterproof material. Unlike previous designs this tunnel's flexibility allows it to be used on uneven terrain.

3017 CALVERT, W., and STIRLING, I. (1985)

Winter Distribution of Ringed Seals (Phoca hispida) in the Barrow Strait Area, Northwest Territories, Determined by Underwater Vocalizations; Can. J. Fish Aquat. Sci., Vol. 42, No. 7, pp. 1238-1243.

In order to assess underice distribution of ringed seals (Phoca hispida) in winter, we made recordings from 23 to 30 April 1982 at 32 sites chosen to represent different habitats in the High Arctic. By regressing the vocalization rate at each site against variables for habitat quality, we found that sites in smooth interisland channels had significantly more vocalizations than sites in bays, and sites with frequent human activity had vocalization rates similar to the overall average. Although differences in vocalization rates correlated with some measured and estimated habitat

variables, there was too much overlap between sites for vocalization rate alone to be useful in separating suitable and unsuitable pupping habitat. Recordings made at one site over 4 d showed a diel cycle in which vocalization rate was highest from about 08:30 to 16:30 and lowest at night.

3018 CARTAR, R.V., and LYON, B.E. (1988)

The mating system of the Buff-breasted Sandpiper: lekking and resource defense polygyny; Ornis Scandinavia, Vol. 19, No. 1, pp. 74-76.

To date, lekking has been the only reported mating system of the Buff-breasted Sandpiper. Here, we describe apparent resource defense polygyny in this species, and speculate on why it occurs.

3019 CHAPDELAINE, G., GASTON, A.J., and BROUSSEAU, P. (1986)

Censusing the Thick-billed Murre colonies of Akpatok Island, NWT; Env. Can., Can. Wildl. Serv., Progress Notes No. 163, 9 p.

The large colonies of Thick-billed Murres (Uria lomvia) on Akpatok Island have been familiar to local Inuit for many centuries, giving the island its name, "isle of murres". The first ornithological exploration of the island was made by an Oxford University expedition in 1931. However, no attempt was made to census the murre colonies, although their position was mapped. In 1954, L.M. Tuck and J.B. Millar of the Canadian Wildlife Service (CWS) visited the island for 6 weeks in July and August. Tuck estimated that a maximum of 300 000 murres were present on the cliffs at the south end of the island and 900 000 at the north end. These numbers translate into about 150 000 and 450 000 breeding pairs. More recently, an aerial survey of the island by D.N. Nettleship in 1972 confirmed the position of the colony boundaries. Tuck estimated that Akpatok Island had one of the largest concentrations of Thick-billed Murres in Canada.

3020 COMPUHEAT SERVICES CANADA INC. (1986)

Infra-red detection and acoustic deterrent study Cape Churchill, Manitoba, 1984; Report to Govt. of the N.W.T., Renewable Resources, Yellowknife, File Report No. 55, 49 p.

A two part study was carried out by Compuheat Services Canada Inc. under the auspices of the Government of the Northwest Territories bear detection and deterrent research and training program at Cape Churchill, Manitoba in November 1984. Part one was implemented to test the feasibility of using an infra-red system to detect (and also census) polar bears (Ursus maritimus) under natural arctic winter conditions, and to assess this system's usefulness as an early warning device. Part two consisted of a preliminary investigation into the feasibility of using an acoustic system as an effective and versatile deterrent system, which is physically harmless to polar bears. It was implemented to observe the effects of acoustic stimulation on bear behaviour and to determine any possible optimal frequencies for deterring these animals in their natural habitat. Results of part one indicate that the infra-red wavelength band of 8-14 microns is practical for use in detecting polar bears in their natural habitat, despite adverse weather conditions. The early warning device interfaced into the infra-red system proved to be 100% effective. The complete system was portable, simple to install and operate, and required little maintenance. Results of part two showed that most bears were sensitive to the 0.1 - 9.0 kHz range of frequencies, and were most effectively deterred at frequencies of 1.0 - 4.0 kHz. There was some indication that when this stimulus was presented in a pulsed mode it produced better results. Because of the small sample size and the limited testing period, further investigation is recommended to obtain conclusive results. A list of possible influencing factors is offered for consideration for further testing.

3021 CONOVER, R.J. (1988)

Comparative life histories in the general Calanus and Neocalanus in high latitudes of the Northern Hemisphere; Hydrobiologia, Vol. 167-168, pp. 127-142.

At least nine species of Calanidae occupy the area of interest, four in the Atlantic and five in the Pacific. All store wax esters and probably can undergo diapause. Latitudinally overlapping or onshore-offshore associations of two or more species occur in both oceans. Interzonals, with reduced mouth parts in the adult female, are endemic to the Pacific sub-arctic gyre where their life cycles are completed in one year. Presumably its nearly closed circulation and environmental stability have favored the evolution of endemic species well adapted to those conditions. Lack of ice- and/or salinity-induced stability also limits blooms there. The sub-arctic Atlantic contains several smaller oceanographic features, open to both arctic and Atlantic influences and populated by species of different origins. Arctic species can behave as interzonals but may also require two or more years to complete their life cycles. Females may need to feed one year to reproduce the next and therefore they retain functional mouthparts. In some places in the North Atlantic, blooms may start in the sub-ice zone and seed the remaining euphotic zone. There the earliest stages of some of the Calanus species can develop close to the ice, using primarily ice algae as food, while the remaining stages are adapted to utilize brief periods of intense primary production in the water column. Salinity-induced stability and shallow water favor blooms in the boundary waters of both oceans, which may be of greater importance in the Atlantic because of the proportionally greater area of continental shelf there. In both oceans the smaller species of Calanidae can produce up to three generations per year.

3022 CONOVER, R.J., BEDO, A.W., and SPRY, J.A. (1988)

Arctic zooplankton prefer living ice algae: a caution for zooplankton excretion measurements; J. Plankton Res., Vol. 10, No. 2, pp. 267-282.

Regardless of how they were killed, dead ice algae were less desirable as food to several arctic copepods (Pseudocalanus sp., Calanus glacialis, Metridia longa) than living ice algae. For Pseudocalanus, the only species tested, the presence of dead ice algae also depressed respiration and ammonia-excretion rates. In the short run, food quality (i.e. whether living or dead) had a greater effect on copepod metabolism than food quantity. Pre-conditioning for 48 h, and conditions in the natural environment to which the animals had become acclimated, also had a marked effect on their metabolic performance, but did not mask the effect of morbidity in the food supply. We conclude that dead algae should not be used as a substitute ration for living food in certain types of metabolic experiments without prior comparison of suitabiljty.

3023 CONOVER, R.J., HERMAN, A.W., PRINSENBERG, S.J., and HARRIS, L.R. (1986)

Distribution of and Feeding by the Copepod Pseudocalanus Under Fast Ice During the Arctic Spring; Science, Vol. 232, pp. 1245-1247.

The arctic copepod Pseudocalanus can be highly aggregated in the first few centimeters under landfast ice during spring in concentrations up to 10^6 per cubic meter. Chlorophyll-derived pigments in the water, the abundance of animals, and their gut pigment index show fluctuations that may be tidally related. Short-term grazing experiments performed at -1.7°C, in which ice algae was used as food, yielded feeding rates comparable to the highest known for the genus. Arctic Pseudocalanus seem to feed opportunistically near the ice-water interface, either directly on the attached epontic (under ice) algae or as it erodes from the ice.

3024 CORNISH, B.J., and DICKSON, D.L. (1986)

Bird surveys of McKinley Bay and Hutchison Bay, Northwest Territories, 1981-1985; Env. Can., Can. Wildl. Serv. report prepared for CWS and DIAND, 61 p.

A five-year monitoring study of waterbird abundance and distribution at McKinley Bay, Northwest Territories, was conducted from 1981 to 1985. The main objective was to gain baseline data on annual population fluctuations of moulting diving ducks, prior to extensive development of the bay. McKinley Bay has been identified as a preferred site for a medium draft harbour to support oil and gas production in the Beaufort Sea. The data obtained in this study will serve as a data base to assess the effect of future harbour development on the birds at McKinley Bay. Aerial surveys were conducted annually at McKinley Bay in mid-summer. Since 1982, a nearby area, Hutchison Bay, was also surveyed as a control. This report gives the results of the aerial surveys conducted in 1985, as well as a summary of the data from all five years of the study. This is the final report on the pre-development phase of the study.

3025 COTA, G.F., PRINSENBERG, S.J., BENNETT, E.B., LODER, J.W., LEWIS, M.R., ANNING, J.L., WATSON, N.H.F., and HARRIS, L.R. (1987)

Nutrient Fluxes During Extended Blooms of Arctic Ice Algae; J. Geophys. Res., Vol. 92, No. C2, pp. 1951-1962.

Estimates of nutrient demand by dense mats of ice algae in the high Arctic indicate that substantial nutrient fluxes are necessary to satisfy the observed growth over the 2-month bloom. In our study area, Barrow Strait, the quantity of nutrients in the surface-mixed layer is about 3-10 times greater than estimates of total demand during the bloom, and nutrient fluxes in the water column are estimated to be of the same order of magnitude as algal demand. The fluxes in the water column are predicted to vary by more than an order of magnitude over the fortnightly tidal cycle, assuming that fluxes depend upon the strength of tidal currents and the vertical nutrient gradients. In the latter half of the bloom, when biomass levels are high, it appears that established populations of ice algae may experience cyclic conditions of nutrient limitation during neap tides when nutrient fluxes are minimal. Contributions from regeneration and brine exclusion from the ice sheet appear to satisfy only a portion of the bloom's total requirement for nutrients.

3026 DICKMAN, M., and OUELLET, M. (1987)

Limnology of Garrow Lake, NWT, Canada; Polar Record, Vol. 23, No. 146, pp. 531-549.

Garrow Lake (area 418 ha, greatest depth 47 m), Canada, Little Cornwallis Island, NWT, Canada, is the northernmost recorded hypersaline meromictic lake. Covered 11 months annually with ice up to 2.4 m thick and internally stratified, its waters at 20 m reach temperatures of 9.1°C from solar heating throughout the year. Salinity varies from less than 0.01% at the surface to over 75% at the bottom. Isostatic uplift isolated the lake from the sea about 3000 BP. Isotope dating indicates that the bottom water has been unmixed for nearly 2500 years. An advancing permafrost wedge appears to have forced brine from pores in rock strata below the watershed into a talik (chimney) in the lake centre. From November 1981 the lake has received approximately 100 tonnes/hr of mine tailings rich in lead and zinc. Dissolved oxygen introduced along with the slurry may be important in reducing anaerobic photosynthetic bacteria.

Biotic diversity is low. Only one vertebrate, Myoxocephalus quadricornis (four-horned sculpin), occurs in the lake. The zooplankton consists of only one species Limnocalanus macruras; phytoplankton includes 51 taxa dominated by flagellates.

3027 DICKSON, D.L. (1987)

Monitoring the impact of oil development on birds in the Beaufort Sea Region; Env. Can., Can. Wildl. Serv., Interim Rep., 74 p.

Oil and gas production could have a significant impact on the hundreds of thousands of migratory birds that use the Beaufort Sea each year for nesting, moulting and staging. Potential impacts include mortality due to oil pollution, loss of habitat due to construction of facilities such as ports and roads, and displacement from habitat due to disturbance. The objective of this study is to monitor the impact of offshore oil and gas development on the birds in the Beaufort Sea region.

3028 DICKSON, D.L., DICKSON, H.L., and AIUDI, G.M. (1988)

Bird surveys at Stokes Point and Phillips Bay, Yukon in 1983; Env. Can., Can. Wildl. Serv., Tech. Rep. Ser. No. 40, Western and Northern Region, Alta., 117 p.

The distribution, abundance and habitat preferences of birds were studied at Stokes Point, Phillips Bay and to a lesser extent, at King Point in the northern Yukon in 1983. These data were gathered to assist in decisions about future development of a port along the northern Yukon coast.

Nesting bird densities at Stokes Point were similar to those found elsewhere on the Yukon Coastal Plain due to the similarity in habitat. The lagoon at Stokes Point was locally important to moulting ducks, with peak numbers of over 500 ducks, mostly Oldsquaw, occurring in mid-august.

Several species of birds occurred in higher densities at Phillips Bay than elsewhere on the Yukon Coastal Plain, primarily due to the deltas and sandspits created by the Babbage and Spring rivers both of which flow into the Bay. Nesting species that were more abundant at Phillips Bay included the Red-throated Loon, Tundra Swan, Semipalmated Sandpiper, Red-necked Phalarope, Glaucous Gull, redpolls and Savannah Sparrow. The river deltas in Phillips Bay were locally important to moulting non-breeding Tundra Swans, Greater White-fronted Geese, Canada Geese, Brant and several duck species. In some years, Greater White-fronted Geese and Canada Geese also reared young there. In midsummer, migrant shorebirds concentrated on the mudflats and ponds at Phillips Bay. During fall migration in September, the Babbage River delta had the highest density of staging Snow Geese in the study area.

During the ground surveys in June, habitat was classified into 13 types and the nesting density of each bird species calculated for each habitat type. Overall, bird densities were more than three times higher in lowland than upland habitats. Shorebird densities and species richness were highest in Wet Sedge and Wet Sedge-Patterned Ground, the two most extensive lowland habitats. Passerine densities and species richness were highest in Tall Shrub, the habitat type dominated by shrubs over 0.5 m high and found primarily in stream river valleys.

The Yukon Coastal Plain is an important nesting area for the Stilt Sandpiper, which has a limited breeding range and which was a common nester throughout the study area. The Yukon Coastal Plain is also nationally important for nesting Long-billed Dowitchers and Yellow Wagtails. Both species were fairly common within the study area, but have a very limited breeding distribution within Canada. The Yukon Coastal Plain is also internationally important to fall staging Snow Geese, as this and several other studies have documented.

3029 DICKSON, H.L., BARRY, T.W., McCORMICK, K.J., and PRACH, R.W. (1983)

Areas of interest to the Canadian Wildlife Service (within the Beaufort Sea Hydrocarbon Production Zone and Associated Transportation Corridors); Env. Can., Can. Wildl. Serv., Western and Northern Region, 223 p.

This report has been prepared in response to the request, by the Beaufort Sea Project Office of Environment Canada, for the Canadian Wildlife Service (CWS) to identify and prepare a report on the areas of interest within the Beaufort Sea hydrocarbon production zone and associated transportation corridors which may potentially be affected by large scale developments in the Beaufort Sea as announced by Beaufort Sea Environmental Assessment and Review Panel (EARP).

The areas defined in this report have been selected primarily on the basis of their importance to birds or mammals, although a few areas are of botanical importance. Four additional sites which CWS has noted as areas of historical interest or as areas of possessing a number of rare plants have been included.

3030 DICKSON, L., and JAQUES, D. (1987)

Identification of Potential Shorebird Nesting and Staging Habitat Sites using LANDSAT Thematic Mapper Imagery in the Outer Mackenzie Delta, NWT, Canada; Rep. from Ecosat Geobotanical Surveys Inc., North Vancouver, B.C. to Env. Can., Can. Wildl. Serv. Edm., 14 p.

Two dates of LANDSAT Thematic Mapper imagery were required to identify potential nesting and staging habitat for shorebirds in the Outer Mackenzie Delta of Northwest Territories. Late June and late July 1986 images were required to identify these sites. Radiometrically and geometrically corrected raw computer data were processed to produce special photographic enhancements of both dates. A mid-infrared, near infrared and visible red waveband combination (Bands 5, 4 and 3, respectively) were used for the June image. Three enhanced images were used from the July imagery. These include a natural color (bands 3-2-1), false color infrared (bands 4-3-2) and mid-infrared (bands 4-5-3) color composites. Visual interpretation of these images together produced maps at 1:50,000 scale showing the locations of over 350 sites which may serve as nesting or staging habitat for shorebirds.

3031 EALEY, D.M., ALEXANDER, S.A., and CROFT, B. (1988)

Fall migration and staging of phalaropes and other waterbirds in the vicinity of Nunaluk Spit, Yukon Territory: 1987; Env. Can., Can. Wildl. Serv., Western and Northern Region, Alta., Tech. Rep. Serv. No. 41, 69 p.

Pre-migratory and migratory activities of birds in the vicinity of Nunaluk Spit, Yukon Territory were monitored from 27 July to 2 September, 1987, as part of a broader investigation of key areas for birds in coastal regions of the Canadian Beaufort Sea. Passage rates were determined for birds flying past an observation post located on the spit. Ground surveys were regularly conducted along 10 km of the spit, and aerial surveys were conducted along the Yukon Territory coastline. Habitat use and distribution of waterbirds and shorebirds, particularly phalaropes, were documented from those surveys. Sixty-eight species were observed during the study period.

Peak passage rates and dates for flights by various species groups were as follows: Ducks and Loons - 32.7 birds/hr, August 11 to 15, and 25.8 birds/hr, August 16 to 20; Geese and Swans - 157.2 birds/hr, August 26 to 30; Shorebirds (excluding Phalaropes) - 35.2 birds/hr, August 6 to 10; Phalaropes - 163.8 birds/hr, August 6 to 10; Larids - 4.9 birds/hr, July 27 to 31, and 3.0 birds/hr, August 21 to 25; Sparrows - 17.3 birds/hr, August 21 to 25. Changes in passage rate and staging were analysed in relation to wind and habitat conditions, primarily for phalaropes. Local wind direction appeared to influence movement of Red-necked Phalaropes past Nunaluk Spit. The relative proportion of Red-necked Phalaropes versus Red Phalaropes declined as fall progressed from 100% to approximately 60%. Past records for phalaropes in the Nunaluk Spit area are compared with 1987 results. Phalarope staging ecology is discussed in relation to other studies made along the Beaufort Sea coast.

The relative importance of the Malcolm and Firth river deltas, Nunaluk Lagoon and Nunaluk Spit to shorebirds and waterfowl is discussed in comparison with other regions of the Beaufort Sea.

3032 FERGUSON, M.A.D. (1987)

Status of Peary Caribou and Muskox Populations on Bathurst Island, N.W.T., August 1981; Arctic, Vol. 40, No. 2, pp. 131-137.

An aerial survey of Bathurst Island, Northwest Territories, Canada, was conducted 10-13 August 1981 to determine if Peary caribou (Rangifer tarandus pearyi) and muskoxen (Ovibos moschatus) had recovered since die-offs in the early 1970s. Sampling intensity was 26%, except for 74% over Polar Bear Pass on central Bathurst Island. Populations of 289 Peary caribou and 208 muskoxen were estimated. The proportion of calves among classified animals was 19% for caribou and 16% for muskoxen. Caribou were concentrated on northern Bathurst, preferring elevations 151-300 m above sea level (asl). Muskoxen were concentrated in southern and central Bathurst Island, preferring elevations below 150 m asl. Spatial separation of the two species during the survey suggested little or no range overlap during late summer. Calf production and/or summer survival in 1981 was significantly greater than in 1974. The 1981 caribou and muskox estimates were only slightly greater than in August 1974. Thus the populations estimated in 1981 showed no marked overall recovery since 1974. Prohibition of harvesting of both species should continue on Bathurst Island. An "extensive-then-intensive" survey design is recommended for future work, based on statistical problems associated with the 1981 and previous surveys.

3033 FORD, J., FORD, D., and NICKLIN, F. (1986)

Narwhals duel in Arctic Seas; National Geographic, Vol. 169, No. 3, pp. 354-359 and p. 362.

While hunting is not a threat to narwhal populations, increasing development of the Arctic could tip the balance against them. Further research will help us protect and understand this animal, one of the most magnificent and mysterious dwellers of the polar seas.

3034 GASTON, A.J. (1985)

The diet of Thick-billed Murre chicks in the eastern Canadian Arctic; The Auk, Vol. 102, pp. 727-734.

I describe the diet of Thick-billed Murre (Uria lomvia) chicks at three colonies in the low Arctic of eastern Canada. These are compared with diets described previously for Akpatok Island in the same area and Prince Leopold Island in the high Arctic. Diets varied more among colonies than among years at the same colony. Indices of similarity showed the diet of chicks at Hantzsch Island to be the most distinct. The diets of all

low-arctic colonies were more diverse than those reported at Prince Leopold Island. Some factors governing differences among colonies are discussed.

3035 GASTON, A.J., NOBLE, D.G., and PURDY, M.A. (1983)

Monitoring breeding biology parameters for Murres Uria spp.: levels of accuracy and sources of bias; J. Field Ornithol., Vol. 54, No. 3, pp. 275-282.

Monitoring of seabird populations by accurate determination of the number of breeding pairs on selected sample areas of their breeding colonies has become an important tool for detecting changes in population size and this in turn may provide a clue to the health of marine ecosystems. The most important seabird family in the Northern Hemisphere is the Alcidae and within this group the most convenient species for monitoring are the Murres (Uria spp.) which are numerous and widespread, and nest on open sites where they can readily be observed.

3036 GASTON, A.J., and DECKER, R. (1985)

Interbreeding of Thayer's Gull, Larus thayeri, and Kumlien's Gull, Larus glaucoides kumlieni, on Southampton Island, Northwest Territories, Can. Field-Naturalist, Vol. 99, No. 2, pp. 257-259.

Gulls with the characteristics of Thayer's and Kumlien's gulls, Larus thayeri and Larus glaucoides kumlieni, were found apparently interbreeding at a colony on Bell Peninsula, eastern Southampton Island. The taxonomic status of L. thayeri may require re-evaluation.

3037 GASTON, A.J., ELLIOT, R.D., and NOBLE, D.G. (1987)

Studies of Thick-billed Murres on Coats Island, Northwest Territories, in 1981, 1984, 1985 and 1986; Env. Can., Can. Wildl. Serv. Progress Notes No. 167, May 1987, 13 p.

Before 1981, the colony of Thick-billed Murres (Uria lomvia) situated just west of Cape Pembroke, Coats Island (62°57'N, 82°00'W), had been visited only briefly by biologists, and there was no information available concerning their breeding biology or ecology. In 1981, as part of the Hudson Strait Seabird Project, A.J. Gaston and S.A. Smith spent 10 days there making a preliminary investigation of the colony, including a census of numbers present.

On the basis of their observations, the island was chosen in 1984 for a detailed study of population dynamics to provide information relevant to the management of the winter hunt of Thick-billed Murres in Newfoundland and Labrador. Almost nothing was then known about the population dynamics of Thick-billed Murres, except for measurements of reproductive success at several colonies. The first stage of the study involved the banding of chicks at Coats Island over a period of several years to provide a substantial known-age population on which observations of age of first breeding and age-specific reproductive success could be based.

3038 GASTON, A.J., DECKER, R., COOCH, F.G., and REED A. (1986)

The Distribution of Larger Species of Birds Breeding on the Coasts of Foxe Basin and Northern Hudson Bay, Canada; Arctic, Vol. 39, No. 4, pp. 285-296.

Aerial surveys of large birds on the coasts of Foxe Basin and northern Hudson Bay were carried out in late June and early July in 1979, 1983 and 1984. Greatest numbers of birds were seen along low-lying coasts backed by wet lowland tundra, particularly where these merged into extensive inter-tidal flats. These areas have emerged from the sea only during the past 2000 years. Even in areas of wet lowland tundra, all species except jaegers appeared to be patchy in their distribution, the patches being unrelated to obvious features of the habitat. We suggest that breeding habitat for many species is not completely occupied, at least in normal breeding seasons. We propose that statutory protection be extended to all or parts of Prince Charles and Air Force islands, which support high numbers of several species and are currently unprotected.

3039 GASTON, A.J., and NOBLE, D.G. (1986)

The possible effect of food availability on incubation and brooding shifts of Brunnich's Guillemot Uria lomvia at Digges Island, Northwest Territories; Seabird, Vol. 9, pp. 47-51.

Among birds which forage long distances from their breeding site, the time involved in travelling to and fro can be an important constraint on breeding performance. Time devoted to travelling can be reduced by increasing the duration of incubation shifts, hence reducing the frequency of visits to the colony. For seabirds both Lack and Ashmole have pointed out that inshore feeders have shorter incubation shifts than offshore feeders, presumably because inshore feeders do not have so far to go to reach their feeding grounds.

Recent comparisons of different measures of reproductive performance among colonies of different size suggest that, for several species of seabirds, large colonies tend to have lower reproductive success and produce lighter fledglings than small colonies. This effect has been attributed to local depletion of food supplies around the colony. Evidence concerning the relationship between colony size of Brünnich's Guillemots Uria lomvia and rates of feeding and weight increment of chicks has already been presented. Among colonies in the eastern Canadian

Arctic, chick growth rates were inversely related to colony size, the lowest being found on Digges Island, Northwest Territories (60°44'N, 77°59'W), where 300,000 pairs breed.

In this paper we compare the duration of incubation shifts at Digges Island with those recorded previously at Prince Leopold Island, Northwest Territories, a colony of 86,000 pairs, where chicks are fed 1.5 to 2 times more often, and normally attain fledging weights approximately 30% higher, than those recorded at Digges Island. If birds at the larger colony have to travel further to find food, we might expect incubation shifts to be longer there than at the smaller colony, in order to reduce travelling time.

3040 GASTON, A.J., and NOBLE, D.G. (1986)

Report on Field - Work carried out on Coats Island 22 July to 10 August 1986; Env. Can., Can. Wildl. Serv., internal report, 30 p.

The satisfactory numbers of 1984 chicks returning to the colony and their concentration in the main areas visible from our blinds, indicate that the project should have no difficulty in fulfilling the initial intention of obtaining information on age-at-first-breeding and age-specific reproductive success. However, the relatively small number of recaptures or resighting of birds banded as adults in earlier years means that we are still not in a position to obtain an adequate estimate of adult survival. This capability should be greatly improved by this year's strategy of banding as many adults as possible in sites easily visible from close range. Even then, it was clear from our experiences in 1986 that we shall need binoculars and telescopes focussing down to closer ranges than those we were using if large numbers of bands are to be read. Ideally, it should be possible to focus down to 1.5 m with binoculars and 4 m (about maximum range with binoculars) for telescopes.

3041 GASTON, A.J., and SMITH, S.A. (1987)

Seabirds in the Cape Dyer-Reid Bay Area of Cumberland Peninsula, Baffin Island, Northwest Territories; Can. Field-Naturalist, Vol. 101, No. 1, pp. 49-55.

We visited the large, multi-species seabird colony situated southeast of Reid Bay 15-30 July 1985 and estimated that 133 000 pairs of Thick-billed Murres (Uria lomvia), 12 000 - 20 000 Northern Fulmars (Fulmarus glacialis) and 1200 - 1300 pairs of Black-legged Kittiwakes (Rissa tridactyla) breed in the area. This is the only colony in the eastern Canadian Arctic, apart from Prince Leopold Island, where all these species nest intermingled. In the absence of any close geographic feature after which to name the colony we propose that it be called "The Minarets", emphasizing the extraordinary erosion features on which many of the birds breed.

3042 GILLMAN, D.V., and SPARLING, P.D. (1985)

Biological data on Arctic charr, Salvelinus alpinus (L.), from the Rat River, Northwest Territories, 1983; Fish. and Oceans, Can. Data Rep. Fish. Aquat. Sci. No. 535, 19 p.

The annual migration of Arctic charr to spawning and overwintering grounds on the Rat River provides the focus for an important domestic fishery for residents of Aklavik and Fort McPherson, Northwest Territories. Biological data (age, length, weight, sex, maturity, fecundity, condition) for Arctic charr captured by a fish weir and trap on the Rat River during 1983 are presented in this report. A total of 1 312 charr were captured during August 1983 of which 752 were spawners and 560 were non-spawners. Enumeration of the 1983 upstream migration was incomplete since high water levels damaged the weir. Charr sampled had a mean length of 413 mm, mean round weight of 1 008 g and a mean age of 7 years.

3043 GOLLOP, J.B., BARRY, T.W., and IVERSEN, E.H. (1986)

Eskimo Curlew: A vanishing species?; Saskatchewan Natural History Society; Special Pub. No. 17, 160 p.

This book is an attempt to compile the Eskimo Curlew's history and what is known about its biology largely in the words of people who were its contemporaries. It brings together the observations and comments of more than 300 people who saw or talked with people who saw Eskimo Curlews. Most of these contacts between people and curlews occurred during the last half of the 19th century as "civilization" expanded in the New World and curlews went from great abundance to great scarcity. How various factors contributed to this decline cannot be documented, but it is possible that curlews were killed by man every day of the year through the 1870s - a period of unregulated hunting and seemingly unlimited bird populations. As a result, this publication relies to a great extent on hunting experiences because more appears in print about them than about other aspects of the curlew's history.

3044 GUNN, A., MILLER, F.L., GLAHOLT, R., and JINGFORS, K. (1985)

Behavioural responses of barren-ground caribou cows and calves to helicopters on the Beverly Herd calving ground, Northwest Territories; in Proc. 1st North Am. Caribou Workshop, Whitehorse, Yukon, Sept. 28-29, 1983, eds. A.M. Martell and D.E, Russell, pp. 10-14.

In June 1982, 16 post-calving aggregations of mainly cow-calf pairs of barren-ground caribou (Rangifer tarandus groenlandicus) were exposed on the Beverly Herd calving ground to a helicopter

overpass and landing nearby. We describe the responses of these caribou to helicopter landings preceded by an overpass at 300 m above ground level. The helicopter landed between 300 and 2200 m from a group of caribou already under observation and shut down for 20 min before taking off. No statistical differences were found between pre- and post-landing behaviours or activity patterns of the exposed caribou. Observed responses of the caribou in the 16 aggregations suggested that walking by cows and walking, trotting, or galloping by calves were greater after the departure of the helicopter. The frequency and duration of nursing bouts was slightly less during landing than before or after the landing; however, the frequency of attempted nursings did not change. Caribou that resumed foraging tended to orient their foraging away from the helicopter landing point and to drift perceptibly away. The caribou in 13 of the 16 aggregations exposed to helicopter landings were displaced 1-3 km by the time they were out of sight.

3045 GUNN, A. (1986)

Muskox & Man; Up Here, June/July 86, pp. 26-29.

The plight of the muskoxen caught the attention of the world, but the success of conservation programs is not so well known. EXPO 86 will draw attention to the thriving new status of muskoxen in the NWT and to opportunities for sport-hunting and photo safaris. Communities such as Cambridge Bay, which are near haunts favored by muskoxen, encourage tourists to come and see the animals in their natural habitat.

Through these shaggy creatures, we seem almost to relive the origins of our own cultures, when we coexisted on equal terms with them. Muskoxen are a potent symbol of the Arctic, hardy and indomitable. It's comforting to know that, having survived the worst nature and man can test them with, they'll endure into the future.

3046 HAIGH, J.C., STIRLING, I., and BROUGHTON, E. (1985)

Immobilization of polar bears (Ursus maritimus phipps) with a mixture of tiletamine hydrochloride and zolazepam hydrochloride; J. Wildl. Diseases, Vol. 21, No. 1, pp. 43-47.

A 1:1 mixture of tiletamine hydrochloride and zolazepam hydrochloride was tested on 39 polar bears in and near Churchill, Manitoba, Canada during October 1983. The mean dose for satisfactory immobilization with a single injection was 5.1 mg/kg. Bears showed signs of ataxia from 1-3 min following injection and were usually sitting within 4 min. The mean induction time, taken as the adoption of sternal recumbency, was 5.1 min. Maximum relaxation was usually seen by about 20 min post-injection. The duration of immobilization appeared to be related to the dose of drug received. In bears that received a dose near the mean, recumbency lasted about 2 hr. Cubs of the year recovered more quickly than adults. Preliminary results indicated that the bears did not suffer respiratory depression and were able to thermoregulate while immobilized. Bears could be handled safely while under the effects of the drug and workers could readily evaluate the state of their sedation by their reactions. The drug did not appear to provide good analgesia at the doses tested.

3047 HANNON, S.J., and BARRY, T.W. (1986)

Demography, Breeding Biology and Predation of Willow Ptarmigan at Anderson River Delta, Northwest Territories; Arctic, Vol. 39, No. 4, pp. 300-303.

Observations on the willow ptarmigan (Lagopus lagopus albus) were made during the breeding season from 1958 to 1985 at the Anderson River Delta, N.W.T. Numbers of territorial males on a 65 ha study area have fluctuated between 7 and 28 over this time, with numbers peaking in 1961-62, 1969 and 1980. Peaks in ptarmigan numbers appear to be fairly synchronous over a large geographical area. Large flocks of males were observed in some years. In 1978, these males, mainly yearlings, had similar wing lengths to, but weighed slightly more than, territorial males. There appeared to be a shortage of hens in 1978, possibly caused by differential mortality during the winter. Mean clutch size ranged from 8.7 to 10.4 and mean number of fledged chicks per brood ranged from 6.3 to 6.9. Within North America clutch size of willow ptarmigan does not appear to increase with increasing latitude. As in other localities, raptors and foxes appeared to be the main predators of ptarmigan. More males than females were killed on the breeding area, but this could have been because more males were present.

3048 HAWKINGS, J.S. (1987)

Population status of migratory waterbirds on the Yukon coastal plain and adjacent Mackenzie Delta; Env. Can., Can. Wildl. Serv., Pacific and Yukon Region, Tech. Rep. Series, No. 28, 65 p.

The status of waterbird (loons, swans, geese, ducks, cranes, jaegers, gulls, shorebirds, and seabirds) populations is summarized for the coastal plain of northern Yukon, and the Yukon portion of the Mackenzie Delta. Estimates of bird density and total population size during spring, summer and fall are presented and discussed, based on research in the area during the period 1971-1985. The waterbird fauna of the area is well known as a result of these fifteen years of research. The most significant components of this avifauna from a national perspective are the fall concentrations of lesser snow geese (potentially the entire western Canadian arctic population) throughout the coastal plain, and a midsummer concentration of 10,000-15,000 molting seaducks at Herschel Island. Nesting shorebirds on the coastal plain may also be of national significance. Of lesser significance are a glaucous gull

colony at Escape Reef, and tundra swans nesting and molting on the Babbage River Delta and the Yukon part of the Mackenzie Delta. A breeding colony of black guillemots at Pauline Cove, Herschel Island, is also a unique feature. As a breeding ground for ducks, geese, and swans, the area is of minor importance compared with the Old Crow Flats or entire Mackenzie Delta. Although the avifauna is well known, the sizes of breeding populations of many species on the coastal plain are still poorly known. This is largely due to a lack of effort in determining (1) densities of breeding birds in particular habitats; and (2) the amount and distribution of those habitats throughout the coastal plain.

3049 HAYES, R., and MOSSOP, D.H. (1982)

The recovery of an interior peregrine falcon population in the northern Yukon Territory; in Proc. Raptor Management and Biology in Alaska and Western Canada, eds. W.N. Ladd and P.F. Schempf, Feb. 17-20, 1981, Anchorage, Alaska, U.S. Dept. Interior, Anchorage, pp. 234-243.

Generally stable occupancy and declining productivity were observed between 1967-75 in the peregrine falcon (Falcon peregrinus anatum) population breeding on the Porcupine river in the northern Yukon Territory. Since 1975, a gradual increase in the number of occupied and productive nest sites was recorded, followed by a sharp increase in 1978 in both parameters. The occupancy rate has remained since 1978, but a productivity decline was observed in 1980. Pesticide data from a total of 10 addled eggs collected in 1973 and 1980, and eggshell measurements from 10 broken eggs collected between 1977 and 1980, indicate 20-23 percent shell thinning. This range exceeds the critical level of 17 percent thinning calculated for the peregrine falcon, and would predict a declining trend in the population. Our results suggest that pesticide-depressed populations may be able to achieve stable breeding levels. Additionally, breeding success may increase sharply if breeding conditions are especially favorable. Our data suggest the early breeding period is critical in regulating annual productivity. It is hypothesized that the physiological conditions of breeding females may be the key factor in regulating annual breeding success. A hypothesis is discussed which uses nesting phenology as a predictive indicator of annual breeding success in high-latitude peregrines.

3050 HEARD, D.C., and CALEF, G.W. (1986)

Population dynamics of the Kaminuriak caribou herd, 1968; Rangifer, Special Issue No. 1, pp. 159-166.

The Kaminuriak caribou herd apparently declined from about 120 000 animals in 1950 to 63 000 in 1968. Beginning in 1968 documentation of herd trend was based on the estimate of the number of breeding (pregnant and post-partum) females on the calving ground during the birth peak. It appeared as if we understood the basic population processes responsible for the decline when we correctly predicted a drop from 14 800 breeding females in 1977 to 13 000 in 1980. However a three-fold increase, to 41 000 breeding females in 1982, and continued growth thereafter, was unanticipated. Most of that increase must have resulted from an immigration of cows to the herd's traditional calving ground around Kaminuriak Lake, although increased birth rates, and increased survival rates also contributed to herd growth. Immigrant cows probably came from the northeastern mainland of the NWT.

3051 HENRY, G., FREEDMAN, B., and SVOBODA, J. (1986)

Survey of Vegetated Areas and Muskox Populations in East-Central Ellesmere Island; Arctic, Vol. 39, No. 1, pp. 78-81.

The results of 1981-84 summer helicopter surveys and ground reconnaissance of east-central Ellesmere Island are presented. This was the first systematic ecological survey to be conducted in this region of the Canadian High Arctic. Central Ellesmere Island is dominated by two large ice fields separated by the deglaciated Sverdrup Pass (79°N). Muskox migrate freely through the 70 km long corridor between the Fosheim Peninsula and some lowlands on the east coast, but large areas of suitable habitat were found unused on the central east coast. Muskox densities in Sverdrup Pass were comparable with those at other arctic sites, as were their reproduction rates (proportion of calves). Vegetated areas (>5% cover) constituted only 5% of the total surveyed land area and were largely restricted to coastal lowlands and the Sverdrup Pass valley.

3052 HOGG, E.H., DICKSON, H.L., and DICKSON, D.L. (1986)

Ground surveys to evaluate habitat use by birds along the Canadian Beaufort Sea coast 1981-1982; Env. Can., Can. Wildl. Serv., Western and Northern Region, 70 p.

The study was undertaken to obtain information on the distribution, species composition and habitat preferences of birds found along the Canadian portion of the Beaufort Sea coast during midsummer of 1981 and 1982. Thirty ground transects, totalling 107.7 km in length, were surveyed at nine sites. This report represents part of the ongoing Canadian Wildlife Service project entitled "Coastal Distribution of Migratory Bird Resources of the Beaufort Sea", which is presently funded, in part, by the Northern Oil and Gas Activities Program (NOGAP). A total of 7795 birds, comprised of 51 species, were recorded. One hundred and thirty vascular plant species (including subspecies) were collected in the habitats along the transects.

Habitat features which were the most important factors governing bird distribution and abundance

were as follows: (1) the abundance of lakes and ponds; (2) moisture levels; (3) upland versus lowland habitats; (4) substrate type and; (5) whether the habitat was coastal or inland. Differences in vascular plant species composition within otherwise similar habitats had no apparent effect on the degree of habitat utilization by birds.

Waterfowl densities were highest in the ponded well-vegetated coastal habitats below the storm tide line. Shorebird densities were highest inland on monocot wetlands with ponds, although substantial numbers also used the coastal ponded habitats that were either well-vegetated or sparsely vegetated mudflats. Sparsely vegetated sand beaches had low densities of birds, but contained the highest densities of glaucous gulls and attracted certain uncommon shorebird species including the semipalmated sandpiper and sanderling. Upland habitats, dominated by monocots, harbored the highest densities of passerine birds, most of which were lapland longspurs.

3053 HOLYOAK, D.T. (1983)

Notes on the birds of southwestern Banks Island, Northwest Territories, Canada; Bull. Brit. Orn. Cl., Vol. 103, No. 2, pp. 37-39.

The southwestern area of Banks Island, (c. 72°N, 125°W) arctic Canada, was visited from 30 June to 9 August 1981 with an expedition carrying out geological research. There were frequent opportunities to make ornithological observations. Two of the bird species seen have not previously been recorded from Banks Island, 2 others are little known there and one had not previously been found nesting. This note records these, along with a list of the breeding birds found in the region around Sachs Harbour.

3054 HOLYOAK, D.T. (1983)

Freshwater mollusca on Banks Island, Arctic Canada; J. Conchology, Vol. 31, No. 4, pp. 259-260.

Non-marine Mollusca were studied around Sachs Harbour, SW Banks Island, N.W.T., Canada (72°N, 125°W) in July and August 1981. This region has a severe climate, with mean annual air temperatures of -14°C (February mean -31°C, July mean +5°C). It is within the zone of continuous permafrost and has open tundra vegetation. No terrestrial Mollusca were found despite extensive searches and field-sieving in varied habitats, and none have been reported from this far north in arctic Canada.

3055 HUMBLE, L.M., and RING, R.A. (1985)

Inoculative freezing of a larval parasitoid within its host; Cryo-Letters, Vol. 6 pp. 59-66.

Larvae of the endoparasitoid, Syndipnus n. sp., freeze by inoculation within the freezing tolerant larvae of their host, Amauronematus sp. nr. amentorum. Freezing of the late-instar endoparasitoid is evident as a multiple freezing event on the host freezing curve. When removed from their host, the parasitoid larvae supercool an additional 10°C.

3056 KERBES, R.H. (1986)

Lesser Snow Geese, Anser c. caerulescens, nesting in the western Canadian Arctic in 1981; Can. Field-Naturalist, Vol. 100, No. 2, pp. 212-217.

A total of 103 800 pairs of nesting Lesser Snow Geese (Anser caerulescens caerulescens) in the western Canadian Arctic was estimated from aerial photographs obtained in June 1981, an increase of 22% over the total estimated by similar methods in 1976. In both years most birds were in the Egg River colony on Banks Island with small proportions in the Anderson River (4% in 1981, 2% in 1976) and Kendall Island (1% in both years) colonies. The density of nesting birds increased greatly between years, especially at Egg River, where it was over four times greater in 1981 than it was in 1976, owing to less snow-free area at the beginning of the 1981 season. This population can be monitored more accurately on its breeding grounds than on its wintering grounds.

3057 KINGSLEY, M.C.S. (1985)

Distribution and abundance of seals in the Beaufort Sea, Amundsen Gulf, and Prince Albert Sound, 1984; Fish. and Oceans, Environmental Studies Revolving Funds Report, No. 025, Ottawa, 16 p.

The fourth in a series of seal monitoring surveys was flown over the Beaufort Sea, Amundsen Gulf, and Prince Albert Sound from 15-21 June 1984. Ice conditions in the Beaufort Sea were intermediate between the extremes of 1981 and 1982; the seal numbers there continued to be stable. The estimated population in Amundsen Gulf was down to 32 000 - 56% of the 1982-1983 level - but that in Prince Albert Sound continued constant at 18 000. Regressions showed ringed seal habitat preferences in accordance with earlier results, and no effect of industrial activity.

3058 KINGSLEY, M.C.S., NAGY, J.A., and REYNOLDS, H.V. (1988)

Growth in length and weight of northern brown bears: differences between sexes and populations; Can. J. Zool., Vol. 66, pp. 981-986.

Growth curves were fitted to data on age, length, and spring weight for individuals from three populations of the brown bear, Ursus arctos, in northern Canada and northwest Alaska. Females reached 90% of asymptotic length before sexual maturity and before the age of first production. Their weight remained approximately in proportion

to the cube of their length. Males reached 90% of asymptotic length 0.7 to 1.7 years later than females, and had asymptotic lengths 10-15% greater. Males continued their growth in weight even longer, and reached asymptotic weights 80-100% greater than females. Variation between these populations was small compared with the total range of variation in the species.

3059 KORCZYNSKI, R.E. (1985)

An Enigmatic Protozoan Infection in the Isopod Mesidotea (= Saduria) sibirica from Herschel Island; Arctic, Vol. 38, No. 4, pp. 336-337.

The benthic isopod Mesidotea (=Saduria) sibirica from the Herschel Island waters, Yukon Territory, was found to be internally infected with an extra- cellular protozoan parasite of uncertain identity. The infection is systemic. This is the first reported incidence of an infection in the isopod population in the Herschel Island waters.

3060 KUKAL, O., and KEVAN, P.G. (1987)

The influence of parasitism on the life history of a high arctic insect, Gynaephora groenlandica (Wöcke) (Lepidoptera: Lymantriidae); Can. J. Zool., Vol. 65, pp. 156-163.

The life history of Gynaephora groenlandica was studied in the high arctic at Alexandra Fiord, Ellesmere Island. Life history events (larval development, pupation, adult emergence, mating, oviposition, hatching, and moulting to the second larval instar) occurred only in the 3-4 weeks before mid-July. Larvae fed mainly on Salix arctica. They stopped feeding by the end of June, hid, and spun hibernacula. Nineteen percent of third- and fourth-instar larvae were parasitized by the wasp Hyposoter pectinatus (Ichenumonidae); 52% of fifth- and sixth-instar larvae and pupae were parasitized by the fly Exorista sp. (Tachinidae). We estimated that G. groenlandica has a life cycle lasting 14 years. Parasitism caused 56% of overall mortality, whereas cumulative winter mortality was calculated as 13% of a cohort passing through a 14-year life cycle. Peak of activity of adult parasitoids coincided with inactivity of Gynaephora larvae during July. Selective pressure of parasitism may restrict development of G. groenlandica to a short period before adult parasitoids are most active. The importance of parasitoids in the life history of G. groenlandica suggests that parasitism is as significant as climate in population regulation of insects living in the high arctic.

3061 LACHO, G. (1986)

Analysis of Arctic cod stomach contents from the Beaufort Shelf, July and August, 1984; Fish. and Oceans, Can. Data. Rep. Fish. Aquat. Sci., No. 614, 14 p.

Arctic cod (Boreogadus saida Lepechin) from bottom trawl catches in the southern Beaufort Sea during July and September, 1984, were analyzed for food items. Copepods appear to be an important part of the diet of cod captured during this study, especially Pseudocalanus elongatus from the July survey Limnocalanus macrurus from fish caught in September trawls. Results of feeding analysis for fish caught off the Tuktoyaktuk Peninsula and Herschel Island are summarized in this report.

3062 LUNN, N.J., and STENHOUSE, G.B. (1985)

An observation of possible cannibalism by polar bears (Ursus martimus); Can. J. Zool., Vol. 63, No. 6, pp. 1516-1517.

We observed a case of cannibalism by a 23-year-old adult male polar bear in very poor physical condition on Southampton Island, N.W.T. It had apparently killed an adult female and was feeding on the carcass. Cannibalism among polar bears does occur under natural conditions. It is difficult to document how often this occurs and of what ecological significance it might be.

3063 LUNN, N.J., and STIRLING, I. (1985)

The significance of supplemental food to polar bears during the ice-free period of Hudson Bay; Can. J. Zool., Vol. 63, No. 6, pp. 2291- 2297.

Polar bears were studied near Churchill, Manitoba, to evaluate the possible importance of supplemental food. Once ashore, bears became segregated by age and sex; family groups and pregnant females moved inland into a denning area, while single bears, especially adult males, remained along the coast. Bears were inactive and fed little. Analysis of blood samples taken from bears in the denning area suggested that they also were not feeding. By remaining inactive, they are able to minimize energetic demands and the chance of hyperthermia. After 2 months ashore, some bears, mainly family groups and subadults, fed in the Churchill dump. The data indicated that individual needs and learning were major factors determining which bears used the dump. Adult males did not feed there even though they may have been there previously as cubs or subadults. Bears which fed in the dump were significantly heavier than those which did not. There was no evidence that bears using the dump gained either reproductive or survival advantages. We conclude that polar bears will use supplemental food sources which are available or if they have previously learned their location; however, it is not necessary for their survival.

3064 MacINNES, C.D., and KERBES, R.H. (1987)

Growth of the Snow Goose, Chen caerulescens, colony at McConnell River, Northwest Terri-

tories: 1940-1980; Can. Field-Naturalist, Vol. 101, No. 1, pp. 33-39.

The McConnell River Snow Goose (Chen caerulescens) colony apparently was established in the early part of this century. Historical population estimates and recent counts from aerial photographs showed very rapid growth, from about 7000 nesting pairs in 1941 to 163 000 in 1973, levelling off thereafter. Local reproduction cannot account for the rapid growth, and both immigration and emigration are thought to have occurred. Feeding in croplands during migration and improved habitat in winter may have led to greater survival and perhaps to large numbers of non-breeders on increasingly crowded nesting areas. This overcrowding, combined with unfavorable conditions as in a late spring, might help the birds overcome their normal site tenacity to make a mass relocation.

2993 MacLEAN, B. (1986)

CSS HUDSON Cruise 86-027; Geol. Surv. Can., Atlantic Geoscience Centre Cruise Report, 36 p.

3065 MANNING, D.P., COOPER, J.E., STIRLING, I., JONES, C.M., BRUCE, M., and McCAUSLAND, P.C. (1985)

Studies on the Footpads of the Polar Bear (Ursus maritimus) and their Possible Relevance to Accident Prevention; J. Hand Surgery, Vol. 10-B, No. 3, pp. 303-307.

The incidence of slipping accidents is unknown, but accident and emergency departments in the United Kingdom probably treat over one million injuries per annum caused by slipping of the feet. Many injuries to farm livestock are caused by slipping. Previous research led to speculation that some animal species may have developed slip-resistant feet and the polar bear was chosen for a study of adaptation to a slippery environment. Feet were photographed and a footpad was sectioned and examined by light and electron microscopy. Hardness of the footpads of two tranquilized bears was measured. The footpads were found to have a rough papillary surface overlying a soft dermis containing a dense network of collagen and elastic fibres. These findings support a hypothesis that shoe solings for use on an icy substrate should be soft with a hardness value in the region of 24 on the Shore A scale. The surface should be covered in conical projections having a mean diameter of 1 mm. Further work on the feet of animal species could lead to a better understanding of slip-resistance and reduce injuries to humans and livestock.

3066 McCORMICK, K.J., (1988)

Lesser Snow Goose Colonies In the Pelly Lake Area, Northwest Territories; Env. Can., Can. Wildl. Serv. Progress Notes No. 178, June 1988, 3 p.

Breeding Lesser Snow Geese (Anser caerulescens) were first recorded in the Pelly Lake area in July 1984. Altogether 362 adults and 55 young were counted between the confluence of the Bullen and Back rivers and the east end of Garry Lake. Additional large flocks of young and adults were present at Pelly Lake but could not be accurately counted.

A mid-July 1986 survey disclosed approximately 2200-2600 breeding Lesser Snow Geese at five sites. The numbers observed at each colony were probably underestimated because numerous pairs, with their young, were leaving the nesting sites at the time of the survey. The presence of these nesting concentrations was attributed to the late spring throughout much of the central Arctic. The observers supposed that the geese had resorted to nesting in this area after discovering that their traditional nesting sites in the Queen Maud Gulf Bird Sanctuary were still snow-covered.

I revisited the Pelly Lake area in 1987 and in this paper present my observations and speculate on the future of the Lesser Snow Goose colonies there.

3067 McCORMICK, K.J., and ARNER, B.D. (1986)

A survey of moulting Canada geese in the Bathurst Inlet and Back River areas, Northwest Territories; Env. Can., Can. Wildl. Serv., Yellowknife, NWT, Tech. Report No. 86-1, 62 p.

A survey of moulting Canada geese was conducted from 23-28 July, 1984. The objectives of the study were: 1) to determine the distribution and abundance of moulting Canada geese in the vicinity of Bathurst Inlet and along the Hood, James, Burnside, Western, Huikitak, Ellice, and Back rivers, 2) to evaluate the importance of Key Habitat Sites in the study area, 3) to determine the subspecific composition of the moulting flocks, and 4) to record ancillary information on other wildlife in the study area.

A total of 9,697 Canada geese was observed. The approximate distribution was: Back River system - 7893, Ellice River - 1162, Huikitak River - 144, Bathurst Inlet - 106, and inland areas - 362. Approximately 70% of the birds on the Back River system were concentrated within the Middle Back River Key Habitat Site. It is recommended that the Key Habitat Site be extended westward to the junction of the Baillie and Back rivers.

Concentrations of lesser snow geese were recorded at: lower Ellice River - 54, Bullen-Back River junction to the east end of Upper Garry Lake - 467, and lower Back River - 403. This represents the first record of breeding lesser snow geese in the Upper Garry Lakes area.

3068 McCORMICK, K.J., and POSON, B. (1986)

A survey of Lesser Snow Geese and Canada Geese on Jenny Lind Island, Northwest Territories; Env. Can., Can. Wildl. Serv., Western and Northern Region, Yellowknife, Habitat Mgm. Section internal report, 21 p.

A helicopter survey of Jenny Lind Island was conducted on 09 and 10 July 1985, with the objectives: (1) foremost, to determine the distribution and abundance of Lesser Snow Geese; (2) to determine the distribution and abundance of Canada Geese; (3) to evaluate Jenny Lind Island as a key terrestrial habitat site; and (4) to record ancillary information on other wildlife of the area.

A total of 10,837 Lesser Snow Geese and 323 Canada Geese were observed during the survey which included approximately 20 percent coverage of the Island. Estimated 1985 populations on the Island are ±54,000 Lesser Snow Geese (±17% at 95% C.L.) and ±1,500 Canada Geese.

A Lesser Snow Geese colony of this magnitude was previously undocumented. This colony adds substantially to the known population in the central Arctic, supporting more than three percent of the Canadian breeding population of Lesser Snow Geese. Therefore, Jenny Lind Island is considered a key terrestrial habitat site as identified by McCormick et al. (1984).

Additional surveys to confirm the Lesser Snow Goose breeding population on Jenny Lind Island are recommended. A vegetation monitoring program to evaluate the impact of this population on the habitat should also be considered.

3069 MECH, L.D. (1987)

At Home with the Arctic Wolf; National Geographic, Vol. 171, No. 5, pp. 562-593.

The gray wolf's cry once echoed from coast to coast and far south into Mexico. Amid persecution and loss of habitat, the wolf has made its stand in the north woods and Arctic tundra. Canada has some 50,000, with 4,000 to 6,000 in Alaska, 1,200 in Minnesota, and a few elsewhere in the U.S.

Perhaps 17 subspecies of the gray wolf remain in North America, including the white arctic wolf, Canis lupus arctos. It ranges north of latitude 75°, a silent vastness it still has largely to itself.

Although Mech's pack knows the scent of man from visits to lonely installations such as weather stations, he feels that their basic behavior is unaffected. He hopes to prevent the pack's harassment by leaving its location undisclosed - somewhere on Nebraska-size Ellesmere Island.

3070 MILLER, F.L. (1985)

Some physical characteristics of caribou spring migration crossing sites on the Dempster Highway, Yukon Territory; in Proc. 1st North Am. Caribou Workshop, Whitehorse, Yukon, Sept. 28-29, 1983, eds. A.M. Martell and D.E. Russell, pp. 15-21.

Springtime migration across the Dempster Highway by barren-ground caribou (Rangifer tarandus granti) of the Porcupine Herd was observed indirectly in April 1981 by driving along the Highway and locating caribou trails that crossed the road. Between km 100 and 371, 1681 caribou trails in nine spring migration zones crossed the Dempster Highway. The overall width of those zones averaged 9.0 ± 4.8 km standard deviation, range 2-18 km. Physical characteristics measured at 31 approaches and departures of caribou trails that crossed the Dempster Highway were among the most difficult physical obstructions that caribou would encounter when crossing the highway between km 100 and 371. Snow depth was shallow and did not impede caribou crossing the Highway in spring 1981. When caribou closely parallelled the Highway by travelling on the frozen Blackstone or Ogilvie rivers, they preferred leaving the streams to cross the Highway where the streams flowed against the road embankment or on open areas, muskegs, lateral streams, and gravel ramps. The openness and associated visibility at some caribou crossing sites along the Dempster Highway may be, however, more a function of the presence of the Blackstone and Ogilvie rivers and the funnelling effect of adjacent terrain than active selection by the caribou. Caribou trails crossing the Dempster Highway appeared to be distributed in proportion to the relative occurrence of treed and open road side, although actual paths within an area may have occurred more often on relatively open sites. Caribou managers should strive to minimize the caribou's bad experiences with traffic, hunting, and predator activities in association with the Dempster Highway.

3071 MILLER, F.L., and GUNN, A. (1986)

Observations of Barren-Ground Caribou Travelling on Thin Ice during Autumn Migration, Arctic, Vol. 39, No. 1, pp. 85-88.

In October 1982 we observed the consequences of migrating barren-ground caribou (Rangifer tarandus groenlandicus) encountering lake ice too thin to bear their weight. The observations were made on a portion of taiga winter range of the Beverly caribou herd during autumn migration in the Northwest Territories. We observed caribou hesitating to cross ice that had no snow cover and also saw caribou breaking through ice. Bulls had greater difficulty extricating themselves from the icy water than did relatively light-bodied cows and young individuals. We necropsied one bull that we found dead after it had broken through the ice and remained in the water for more than 20 hours. The

bull had died apparently from stress and hypothermia and had heavily traumatized areas on its forelegs and sternum from struggling to break the ice. We could not evaluate the overall extent of injuries and mortalities to caribou from their encounters with thin ice, although we observed signs that at least hundreds had broken through the ice on different lakes.

3072 MILLER, F.L. (1987)

Peary caribou and muskoxen on Prince Patrick Island, Eglinton Island, and Emerald Isle, Northwest Territories, July 1986; Env. Can., Can. Wildl. Serv., Western and Northern Region, Tech. Rep. Ser. No. 29, 65 p.

An aerial survey to determine numbers and distributions of Peary caribou (Rangifer tarandus pearyi) and muskoxen (Ovibos moschatus) was flown between 4 and 13 July 1986. The survey area included Prince Patrick Island, Eglinton Island, and Emerald Isle, Northwest Territories, in the Canadian Archipelago. A systematic unbounded line transect survey was flown at about 90 m above ground level along transects at 6.4-km intervals, for an overall coverage of about 27%. The survey aircraft was a Bell-206B turbo-helicopter on floats, equipped with an Omega/VLF Navigation System. A four-person survey crew was used. Only 62 caribou and 51 muskoxen (1+ yr-old), 21 caribou calves, and two muskox calves were seen during the survey. Numbers of caribou and muskoxen within the entire survey area were estimated at 247 and 165, respectively. Overall estimated density for all caribou was 1.38 caribou/100 km^{-2} and for all muskoxen was 0.92 muskoxen/100 km^{-2}. The estimated number of caribou was greatest on Prince Patrick Island but the highest density was estimated for caribou on Eglinton Island. Both the estimated number and the estimated density of muskoxen were greatest on Eglinton Island. Caribou calves represented 26.7% of all caribou and muskox calves only 2.5% of all muskoxen seen on and off survey. Large portions of Prince Patrick Island were resurveyed by air once and the whole of Eglinton Island twice at higher coverages between 17 and 29 July 1986. Overall resurvey results supported the overall findings from the aerial survey but some within island differences occurred, particularly for muskoxen. A better estimation of muskoxen on Eglinton Island is 136 at 8.76 muskoxen/100 km^{-2}. Also, a better measure of proportional representation of muskox calves in July 1986 is 7%. Muskoxen appear to have increased within the 1986 survey area by about 27% from 1974. Peary caribou appear to have continued to decline in number within the 1986 survey area by about a further 63% from 1974 and an overall 90% from 1961. The number of Peary caribou summering within the 1986 survey area would not safely support essentially any level of sustained annual harvest; especially, if it involved the removal of breeding age females.

3073 MILLER, F.L. (1988)

Peary caribou and muskoxen on Melville and Byam Martin Islands, Northwest Territories, July 1987; Env. Can., Can. Wildl. Serv., Western and Northern region, Tech. Rep. Ser. No. 37, 58 p.

An aerial survey to determine numbers and distributions of Peary caribou (Rangifer tarandus pearyi) and muskoxen (Ovibos moschatus) was flown between 1 and 22 July 1987. The survey area included Melville and Byam Martin islands, Northwest Territories, in the Canadian Archipelago. A systematic unbounded line transect survey was flown at about 90 m above ground level along transects at 6.4-km intervals, for an overall coverage of about 27%. The survey aircraft was a Bell-206B turbo-helicopter on high-skid gear, equipped with an Omega/VLF Navigation System. A four-person survey crew was used. We observed 418 caribou and 2855 muskoxen on Melville Island and 90 caribou and 70 muskoxen on Byam Martin Island. Numbers of caribou and muskoxen were estimated at about 943 and 5652 on Melville and 98 and 100 on Byam Martin, respectively. Overall estimated mean density for all caribou was 2.2 caribou/100 km^{-2} on Melville and 8.4 caribou/100 km^{-2} on Byam Martin and for all muskoxen was 13.4 muskoxen/100 km^{-2} on Melville and 8.6 muskoxen/100 km^{-2} on Byam Martin. Caribou calves represented 19.4% of all caribou seen on Melville and 18.9% of all caribou seen by Byam Martin. Muskox calves represented 15.2% of all muskoxen seen on Melville and only 2.9% of all muskoxen seen by Byam Martin. Muskoxen have increased markedly within the 1987 two-island survey area by about 140% from 1974. Peary caribou have continued to decline markedly in number within the 1987 survey area by about a further 39% from 1974 and an overall 92% from 1961. The number of Peary caribou summering within the 1987 survey area would not safely support essentially any significant level of sustained annual harvest; especially, if it involved the removal of breeding age females.

3074 MILLER, F.L., BROUGHTON, E., and GUNN, A. (1988)

Mortality of migratory barren-ground caribou on the calving grounds of the Beverly herd, Northwest Territories, 1981-83; Env. Can., Can. Wildl. Serv., Western and Northern Region, Occasional Paper No. 66, 26 p.

The mortality of migratory barren-ground caribou (Rangifer tarandus groenlandicus) on the calving grounds of the Beverly caribou herd, District of Keewatin, Northwest Territories, was investigated in 1981, 1982, and 1983. Two hundred and eighty-seven dead or incapacitated newborn caribou calves were found and necropsied between 31 May and 20 June 1981, 3 and 23 June 1982, and 6 and 17 June 1983. Wolf (Canis lupus) predation was the single most important cause of newborn calf mortality (68.5%), followed by atelectasis (fetal and neonatal) (14.2%), pathophysiological disorders (6.7%), separation or abandonment (6.2%), pneumonia (4.0%), and grizzly bear (Ursus arctos) predation (0.4%).

The samples of cows that died shortly before, during, or after calving in 1981-83 are too small to allow evaluation of the causes and magnitude of mortality among breeding females of the Beverly caribou herd.

Management measures to help safeguard against the deaths of newborn calves, including maintenance of wolf numbers and minimization of human activities on the calving grounds, are discussed.

3075 MILLER, F.L., GUNN, A., and BARRY, S.J. (1988)

Nursing by Muskox Calves before, during, and after Helicopter Overflights; Arctic, Vol. 41, No. 3, pp. 231-235.

Nursing bouts by 15 muskox (Ovibos moschatus) calves were measured to evaluate potential use of nursing behaviour as an indicator of muskox responses to helicopters. The muskox calves nursed 225 times during 313 hours of observation: 63% under undisturbed conditions; 12% when helicopter overflights took place; and 25% following those overflights. During exposure to the helicopter, the calf moved to the cow and then sometimes took the opportunity to nurse. Younger calves nursed relatively longer and more often than older calves; they also performed 68% of the nursings that occurred during helicopter overflights. Frequency and duration of nursing bouts are known to be related to the age of calves. This paper demonstrates that these aspects of nursing vary within or among muskox herds and concludes that observations of nursing at this level of effort cannot be employed with any confidence as a monitoring indicator of muskox response to helicopters.

3076 MOSSOP, D. (1986)

Status of Peregrine Falcon in Yukon; in 1986 Annual Report on Birds of Prey and Non-game Birds, Inventory, Population Studies and Management Projects; Govt. Yukon, Renewable Resources, pp. 1-14.

This is the ninth year of a continuing program to effect the recovery of the Peregrine Falcon (Falco peregrinus) in the Yukon. After the species declined to low levels of abundance in the 60's and 70's, the Government of Yukon became part of a Canada-wide Federal-Provincial effort to secure the species' future and return it to its historic range. The work has included coordinated population monitoring, captive propagation, release to the wild of captive produced young, pesticide research, public education and enforcement protection. (The annual report of 1979: Peregrine Falcon Recovery Project, Yukon Dept. Ren. Res., describes the overall Yukon recovery plan and rationale for the work here reported.)

Two geographic races of the Peregrine are addressed: the anatum or interior race and the tundrius or arctic race. The latter is limited to the North Slope of the Yukon, the former is found south of that birds' range. The two have shown different population dynamics. The interior race declined but maintained a remnant population which allowed a focus for recovery effort. The arctic race declined to total disappearance in the Territory.

In 1986 the project plan was altered from previous years reflecting changing needs for management effort, particularly where the anatum (interior) race is concerned. The apparent recovery of these birds has caused a shift away from a focused project addressing just one sub-population of the race to a more general monitoring of the bird throughout the Territory. The project, in the current year, was designed as part of a Canada-wide survey of the species to be reported in total elsewhere (Part I). The tundrius project was conducted identically to the last two years with the exception that a reassessment was incorporated (Part II).

3077 MOSSOP, D., and BAIRD, G. (1986)

1985 Peregrine Falcon Recovery Project, Govt. Yukon, Renewable Resources, internal report, 13 p.

This project is the eighth year of a continuing effort to affect the recovery of the peregrine falcon (Falco peregrinus) in the Yukon. After severe declines in the 60's and 70's, the Yukon Government has participated in a larger Canada-wide effort with the general objectives of securing the species' future and returning it to its historic ranges. The overall work has included coordinated population research, captive propagation, release to the wild of captive produced young, pesticide research, public education and enforcement protection. (The annual report: Peregrine Falcon Recovery Project, Yukon Department of Renewable Resources, 1979, describes the overall Yukon recovery plan and rationale for the present project.)

Two geographic races of the peregrine falcon are addressed by this project: the anatum or interior race (Part I), is considered endangered in Canada; the tundrius or arctic race (Part II), which is limited to breeding on the North Slope, is considered threatened in Canada. The two have shown different population dynamics. The interior race declined sharply, but maintained a remnant which allowed a focus for recovery effort. The arctic race declined to total disappearance in the Yukon; its reintroduction is obviously more complicated.

3078 MOSSOP, D.H., and HAYES, R. (1982)

The Yukon Territory gyrfalcon harvest experiment (1974-80); in Proc. Raptor Management and Biology in Alaska and Western Canada, eds. W.N. Ladd and P.F. Schempf, Feb. 17-20, 1981, Anchorage, Alaska, U.S. Dept. Interior, Alaska, pp. 263-280.

In a 6-year study, the Yukon Government experimented with harvest criteria for eyas gyrfalcons (Falco rusticolus) from a 17,500 km^2 (6,800 mi^2) study area on the Arctic Slope. Open-harvest schemes were rejected in favour of harvest by the management authority. The study population was monitored for 3 years prior to harvest. It produced an average 185 young annually; its breeding density was about one pair per 175 km (109 mi). Ptarmigan numbers peaked and declined during the study. An average of 10 gyrfalcon eyases (approximately 5 percent of annual productivity) were taken annually at about 21 days of age over the last 3 years. No effects on population productivity were detected at this harvest rate. From our harvest model we determined that a minimum of 40 percent of known territories must be productive to safely harvest at the described rate. Techniques of removal are described. Successful applicants paid the costs of capture ($1,000 per bird). Assignment of the harvest was done by a ranking scheme, which placed most birds into breeding projects. By January 1981, of 31 eyases 9 had entered the commercial market, 3 had died, and 18 were in captive breeding projects. The extreme economic value of the gyrfalcon and its effect on their management is discussed.

3079 MOSSOP, D., CAMPEAU, R., and HAYES, T. (1983)

1982 Peregrine Falcon Recovery Project; Govt. Yukon, Renewable Resources, internal report, 32 p.

This project is a continuing effort begun in 1978 to attempt to rebuild peregrine falcon (Falco peregrinus) numbers in the Yukon following the continental decline in that species which occurred in the 1960's and early 1970's. It is the Yukon segment of a much larger Canada-wide effort involving coordinated population monitoring, captive production, release to the wild of captive produced young, enforcement protection and public education. Two subspecies of peregrine falcon are endemic to the Yukon: The anatum or interior race (Part 1) and the tundrius or arctic race (Part 2).

Both have exhibited strikingly different population trends. Basically the anatum race declined sharply but retained a remnant number which still represented one of the largest groups anywhere in Canada even at its lowest ebb. The Yukon was thus in an excellent position to capitalize on this remnant and with a relatively low budget, effect recovery. The tundrius race meanwhile declined to total extirpation and its reintroduction becomes more complicated.

3080 MOSSOP, D., MUNSEN, T., GUENTER, K., and HAWKINGS, J. (1984)

1984 Peregrine Falcon Recovery Project; Govt. Yukon, Renewable Resources, internal report, 18 p.

This project continues effort commenced in 1978 to attempt to rebuild peregrine falcon (Falco peregrinus) populations in Yukon. The peregrine is recognized as an endangered species following drastic decline which occurred in the 1960's and early 1970's. The Yukon has participated in a larger Canada-wide peregrine recovery effort, including coordinated population monitoring, captive propagation, release to the wild of captive produced young, pesticide research, public education and enforcement protection (see Peregrine Falcon Recovery Project report, Yukon, DRR, 1979, for a description of the Yukon recovery plan and rational for the present project).

Two subspecies of peregrine falcon occur in Yukon: the anatum or interior race (Part 1), is considered endangered in Canada; the tundrius or arctic race (Part 2) is considered threatened in Canada. The two have exhibited strikingly different population trends. The anatum race declined sharply but retained a remnant which allowed a relatively low budget recovery effort. The tundrius race declined to total extirpation and its reintroduction has become technically more complex.

3081 MOSSOP, D., WARD, R., and TALARICO, D. (1986)

Raptor Population Inventory and Management Planning (North Slope); in 1986 Annual Report on Birds of Prey and Non-game Birds, Inventory, Population Studies and Management Projects; Govt. Yukon, Renewable Resources, pp. 21-49.

Initial inventory and planning for the management of raptors on the Yukon North Slope has been an ongoing project since the early 1970's. In the interim, much of the area drained by streams of the Beaufort Sea have been covered in initial intensive surveys. As well, various management options have been investigated including reintroduction of an extirpated species (see Peregrine Falcon Recovery project, this report) and harvest of the gyrfalcon, primarily for commercial reasons. The remaining task has been to complete the inventory but more importantly, to draw together all the work that has been done into a comprehensive analysis of raptor populations and an overall management plan for the future of these birds. A grant from Northern Oil and Gas Action Plan (NOGAP), a federal/territorial funding agreement has made the present task possible.

Difficult accessibility of the Yukon North Slope has been the factor limiting human use in the area. With the development of the North Yukon National Park and the Herschel Island Territorial Park, more human activity is expected in the North Slope area. Other options for this area include wilderness tourism, industrial site development and corridor transportation development. In the near future, activities associated with the oil and gas industry (both exploration and production) are the most likely industrial developments to occur.

Although management planning recognizes all North Slope activities, it has prioritized petroleum development activities as its main concern.

3082 NAGY, J.A., RUSSELL, R.H., PEARSON, A.M., KINGSLEY, M.C.S., and LARSEN, C.B. (1983)

A study of grizzly bears on the barren-grounds of Tuktoyaktuk Peninsula and Richards Island, Northwest Territories, 1974 to 1978; Can. Wildl. Serv., Edm., 148 p.

Seventy-one different grizzly bears were captured on a 17,318 km^2 portion of the Mackenzie Delta, including the Tuktoyaktuk Peninsula and Richards Island, N.W.T. Densities varied from one bear per 211-237 km^2 in spring to one bear per 255-262 km^2 in fall.

The population was considered to be stable. Productivity was high as shown by an annual recruitment of 18.4 percent; 85 percent of females were accompanied by an average litter of 2.2 young. The interval between litters was 3.3 years. Stable numbers were maintained principally through a substantial annual harvest and natural mortalities. Males were more vulnerable to harvest than females.

The breeding season was between mid May and the end of June. Females first bred at ages 4.5-7.5 years. Young were weaned at ages 2-3 years.

Grizzly bears of Tuktoyaktuk Peninsula were larger than those of the southwestern and northern Yukon. Significant increases in body weight during the active period (21-70 percent) and losses during winter dormancy (5-34 percent) were recorded. Highly significant correlations between actual body weight and girth measurements were found. Weights predicted for girth measurements are given.

Highly significant correlations between age and skull width were also obtained. Relationships are compared with those of other populations. Ages predicted for skull width measurements are given.

Seasonal changes in pelage color caused by solar bleaching and moult were observed.

Food habits were consistent with those of populations in other northern regions. Some bears relied heavily on Arctic ground squirrels for fall fattening.

Home range data are given. Home ranges of males and females overlapped. The size of home ranges of females appeared to be related to their reproductive status. Adult females showed a high degree of fidelity to specific home range areas and their female cubs demonstrated a similar fidelity to the dams home range following weaning.

Grizzly bears entered winter dens in early October and emerged between the last week of April and the end of May. Information was obtained on den site characteristics.

3083 O'BRIAIN, M. (1985)

Resightings in Ireland, winter 1984/85 of Brent Geese banded on Bathurst Island; Irish Brent Goose Study, Dept. Zoology, Univ. College, Dublin, internal report, 25 p.

As part of a study of the biology of brent on Bathurst Island in summer 1984, geese were trapped and leg-banded during the flightless moult with a view to studying their distribution, movements and associations on the Irish-wintering grounds.

This report summarizes resightings of banded brent in Ireland, winter 1984/85. The objectives are (1) to describe the observed winter range of the Bathurst segment of the brent population, (2) to examine the seasonal movements of banded brent within and between wintering sites, (3) to investigate the influence of habitat utilization on these movements of geese (4) to summarize information on family and pair bonds and (5) to examine for any associations above these groupings on the winter grounds.

3084 O'BRIAIN, M. (1987)

A Preliminary Report on investigations of brent and greater snow geese at Bracebridge Inlet, Bathurst Island, July-August 1986; Irish Brent Goose Study, Dept. Zoology, Univ. College, Dublin, internal report 15 p.

Studies on brent (Branta bernicla hrota) and greater snow goose (Anser caerulescens atlanticus) were carried out at Bracebridge Inlet, Bathurst Island in July and early August 1986. This research was a continuation of studies initiated on Bathurst Island in 1984 to gather baseline data on the summer biology and habitat of Irish-wintering brent.

In 1984 the major research objectives were to examine numbers and seasonal distribution of the goose populations, study comparatively the breeding behaviour of brent and snow geese and band brent for follow-up studies on their Irish-wintering grounds. In August 1985 further brent, mainly family broods were banded by A. Reed and H. Boyd of the Canadian Wildlife Service.

3085 O'DOHERTY, R., and RING, R.A. (1987)

Supercooling ability of aphid populations from British Columbia and the Canadian Arctic; Can. J. Zool., Vol. 65, pp. 763-765.

Adults and first-instar nymphs of the peach-potato aphid Myzus persicae of Canadian origin maintained under favourable laboratory conditions were capable of extensive supercooling potential, to below -20°C, as were summer morphs which were field collected in British Columbia. Adult Aphis epilobii collected in summer from the Arctic also possessed considerable supercooling capacity. The

cool data are comparable with those gathered in other aphid cold hardiness studies and suggest that a general pattern of supercooling potential may exist in aphid species and may be independent of geographical or habitat origins.

3086 PATTIE, D.L. (1986)

Musk ox density and calf numbers on Devon Island's North Coast; J. Mamm., Vol. 67, No. 1, pp. 190-191.

Musk ox (Ovibos moschatus Zimmermann) populations of five adjacent lowlands on the north coast of Devon Island were surveyed by helicopter on July 31 and August 1, 1984. Visibility during the survey was excellent with prevailing conditions sunny. A grid pattern flown at an altitude of 30 to 40 m covered the lowlands at about 400 m intervals.

A total of 154 musk ox were seen of which 31 were calves. Because the helicopter's approach disturbed the animals, sex and age ratios were ascertained only on Newman-Smith Lowland, the westernmost of the five areas examined. The overall lowland density was 0.6 musk ox km^2. The results of the survey are presented.

3087 POOLE, K.G. (1987)

Aspects of the ecology, food habits and foraging characteristics of gyrfacons in the Central Canadian Arctic; unpub. M.Sc. thesis, Dept. Zoology, Univ. Alberta, 120 p.

A population of breeding gyrfalcons (Falco rusticolus), studied from 1984 to 1986 on a 2,000 km^2 study area in the central arctic, Northwest Territories, occupied 14 to 18 territories each year. The mean distance between all territories was 9.5 km, giving a density that approaches the highest recorded. Tendency for regularity in spacing of territories suggested that carrying capacity was being approached. Most (85%) nests were in abandoned stick nests of ravens (Corvus corax) and golden eagles (Aquila chrysaetos). Mean size of clutch was 3.80 ± 0.52 (SD), brood 2.53 ± 0.89, and productivity 1.50 ± 1.43 fledged young. Variation among years in productivity was correlated with severity of spring weather.

Three prey species (rock ptarmigan (Lagopus mutus), arctic ground squirrel (Spermophilus parryii) and arctic hare (Lepus arcticus)) accounted for 96.5% of the total prey biomass identified. Gyrfalcons responded functionally to the varying availability of prey. Ptarmigan and hares were taken in May and June of all years (98.2% biomass). About 1 July, when nestling gyrfalcons were growing rapidly, juvenile ground squirrels emerged and vulnerability of ptarmigan appeared to decline. The former were used extensively in July and August of 1984 and 1985, but not in 1986, when there was a nearly complete failure of squirrel production and ptarmigan continued to be taken. Spring counts suggested the densities of breeding ptarmigan were relatively constant during the study. Mean weight of prey taken by male gyrfalcons (250 g) was significantly less than those captured by females (330 g). As predicted by optimal foraging theory, larger prey items, on average, were brought to the nest as foraging time away from the nest increased.

Brood size was manipulated at two gyrfalcon nests in 1986. The parent birds responded to altered brood size by compensatory changes in total prey biomass fed to the nestlings, suggesting that food was not limiting brood size. Conditions of food abundance were also observed at nests of unmanipulated broods indicating that food was not limiting during the nestling period. I suggest that spacing of pairs was set during courtship and prelaying when food was most likely to be limiting, because it coincided with the yearly low in prey availability. Supporting this suggestion was the observation that most pairs did not initiate laying until after the spring arrival of migrating ptarmigan.

3088 POOLE, K.G., and BOAG, D.A. (1988)

Ecology of gyrfalcons, Falco rusticolus, in the central Canadian Arctic: diet and feeding behaviour; Can. J. Zool., Vol. 66, No. 2, pp. 334-344.

Diet and aspects of feeding behaviour in a population of gyrfalcons (Falco rusticolus) in the Northwest Territories were examined between 1984 and 1986. Three prey species, rock ptarmigan (Lagopus mutus), arctic ground squirrel (Spermophilus parryii), and arctic hare (Lepus arcticus), composed 96.5% of total prey biomass identified. Ptarmigan and hares were taken in May and June of all years (98.2% of biomass). Juvenile squirrels were used extensively in July and August of 1984 and 1985 but not in 1986, when squirrel production fell to almost zero; ptarmigan continued to be the dominant prey species throughout that summer. Because densities of breeding ptarmigan remained relatively constant during the study, but those of juvenile ground squirrels did not, it appeared that gyrfalcons responded functionally to varying availability of prey. Mean weight (250 g) of prey taken by male gyrfalcons was significantly less than the weight (330 g) of prey taken by females. As predicted by optimal foraging theory, average size of prey brought to the nest increased as time away from the nest increased. Conditions of food abundance were observed at most nests, suggesting that the amount of food available during the nestling period was not limiting production. We suggest that annual production is a function of spacing of pairs, which is set during the courtship and prelaying, when prey availability is at its yearly low and when males must forage for both members of the pair. The fact that most gyrfalcon pairs initiated laying only after the spring arrival of migrating ptarmigan is consistent with this conclusion.

3089 POOLE, K.G., and BROMLEY, R.G. (1988)

Natural History of the Gyrfalcon in the Central Canadian Arctic; Arctic, Vol. 41, No. 1, pp. 31-38.

A population of breeding gyrfalcons was studied from 1982 to 1986 on a 2000 km^2 area in the central Arctic of the Northwest Territories. Each year 14-18 territories were occupied. The mean internest distance was 10.6 km, giving one of the highest recorded densities for the species. There was a tendency for regularity in spacing of territories. Most (85%) nests were in abandoned stick nests of common ravens or golden eagles. Rough-legged hawk nests were not used by gyrfalcons, despite numerous available. Mean date of initiation of laying was 8 May. Mean size of clutch was 3.80 and of brood was 2.53, and mean productivity was 1.50 fledged young. A reduction of 48% from estimated number of eggs laid to number of fledglings was determined. Reproductive success declined with increased severity of spring weather, notably increased days and amount of precipitation.

3090 PRACH, R.W., SMITH, A.R., and DZUBIN, A. (1986)

Nesting of the Common Eider near the Hell Gate - Cardigan Strait polynya, 1980-81; in Eider ducks in Canada, ed. Austin Reed, Can. Wildl. Serv. Report Series No. 47, pp. 127-135.

The biology of the Common Eider (Somateria mollissima borealis) was studied in the vicinity of Hell Gate-Cardigan Strait, which separates Devon and Ellesmere Islands in the Canadian High Arctic, during summers 1980 and 1981. There, a recurring polynya keeps shallow water feeding areas, nesting islands, and coastlines free of ice throughout spring and summer. Those conditions allow nesting populations to form distinct colonies; at most other High Arctic locations nests are widely dispersed. Aerial surveys and nest counts revealed about 635 breeding pairs, most on three small islands. In 1981, an early year phenologically, the first eggs were laid on 6 June and nest initiation terminated on 11 July with a peak occurring 25 June - 3 July. The mean clutch size in 1981 was 3.30 eggs (SD = 0.98, n = 544), a value similar to that reported for the same race in Greenland (3.31 in 1965) and Southern Baffin Island (3.12 in 1976) but less than that in Ungava Bay (3.57 in 1980) and in an earlier sample from southern Baffin Island (3.44 in 1955-56).

Clutch sizes within the study area varied by year and island. Broods left the nesting islands, some of them assembling into crèches (n = 45 family groups) containing 1-17 adult females (mean = 4.6) and 1-36 ducklings (mean = 9.9), and followed the retreating ice edge into adjacent fiords and inlets. Although the typical food of the Common Eider, the blue mussel (Mytilus edulis), was absent from the study area, suitable food items (other molluscs, crustaceans, etc.) were available in sufficient numbers to permit successful breeding.

3091 PROUSE, N.J., (1984)

Biological sampling program: CESAR Expedition; Abstract in Can. Geophys. Union, 11th Annual Meeting, Dalhousie Univ., Halifax, N.S., May 29 - June 1, 1984, p. 102.

A number of investigations relating to the organically derived material in the water column and the kind, number and distribution of organisms below the Arctic ice were carried out on the CESAR expedition. A large scavenging amphipod, Erythenes gryllus, was collected at the bottom (2000 m) with baited traps and preserved for analysis of Po^{210} and lipid content to compare with species captured in other areas, Lycodes frigidus, the glacial eel-pout, was also caught at this depth with a codjig; this represents the first recorded catch of this fish from the Arctic Canadian Basin. Plankton traps and net tows at different depths confirmed the limited vertical migration of zooplankton below the Arctic ice. Water samples taken every 50 m to the bottom indicate very low concentrations of particulate organic carbon and nitrogen but relatively high concentrations of dissolved organic carbon. The significance of these observations will be discussed in relation to other areas of the world's oceans.

3092 PROUSE, N.J., and McALLISTER, D.E. (1986)

The Glacial Eelpout, Lycodes frigidus, from the Arctic Canadian Basin, New to the Canadian Ichthyofauna; Can. Field Naturalist, Vol. 100, No. 3, pp. 325-329.

Sampling at Canadian drifting ice station CESAR in the Canadian sector of the Arctic Ocean, 85°48'26.8"N, 110°43'39.3"W, produced the first Canadian record of Lycodes frigidus. The specimen was caught at a depth of 2075 metres, -0.37°C, and a salinity of about 35.00°/oo. The new English vernacular, Glacial Eelpout, is suggested as a replacement for the former common name, coldwater eelpout, which would apply to almost any eelpout.

3093 RAMSAY, M.A., and ANDRIASHEK, D.S. (1986)

Long distance route orientation of female Polar bears (Ursus maritimus) in spring; J. Zool. Lond. (A), Vol. 208, pp. 63-72.

Mammals in a patchy environment are often required to make regular spatial movements in order to obtain necessary resources. Polar bears (Ursus maritimus) are known to move distances of several hundred kilometres to locate favourable feeding areas or suitable habitats for female maternity denning. This paper describes the routes followed by adult female Polar bears in spring from a region in northeastern Manitoba, Canada, where they had denned over winter, to the sea ice of Hudson Bay where they could hunt seals. Over a five-year period, 74 tracks in snow were followed

for a total distance of 1081 km. Most tracks (n = 64) were made by adult females accompanied by recently born cubs-of-the-year. These family group tracks followed relatively parallel and straight courses toward the sea with a mean heading of 39° but did not follow the shortest straight line distance to the sea. The remaining tracks were made by solitary bears, probably adult females. These tracks had a mean heading similar to that of family groups but travelled more convoluted courses. Solitary bears also frequently dug snow caves and multiple shallow snow pits along their routes, structures never observed along the routes of family groups.

3094 RAMSAY, M.A., and DUNBRACK, R.L. (1986)

Physiological constraints on life history phenomena: the example of small bear cubs at birth; Am. Nat., Vol. 127, No. 6, pp. 735-743.

Attempts to explain ecological phenomena generally rely on simple optimality criteria involving limited sets of variables. Bounds on the adaptive responses available to meet particular ecological challenges are often not considered, and discrepancies between empirical observations and model predictions are frequently attributed to lack of model resolution. It is becoming clear, however, that the processes of adaptation are closely linked to important physiological constraints on the ability of organisms to achieve global ecological optima. This study examines how such physiological contraints may have influenced an important life history characteristic of the eutherian mammals, namely, weight at birth.

3095 RAMSAY, M.A., and STIRLING, I. (1986)

On the mating system of polar bears; Can. J. Zool., Vol. 64, pp. 2142-2151.

Polar bears are intimately associated with arctic sea ice and their distribution is approximated by its winter extent. They are the only terrestrial mammals, other than humans, to have adapted so completely to sea ice, a quite different habitat, spatially and temporally, from that occupied by other terrestrial mammals. We propose that the dynamics of sea ice and the associated variability in access to food have played a major role in the evolution of the social structure and mating system of polar bears. Adult females and males move to areas of the sea ice where the greatest success in hunting is realized. Such regions are unpredictable in location, however, both seasonally and annually. Because female distributions are unpredictable, adult males are unable to defend stable territories that will encompass the home ranges of one or more females and may instead distribute themselves among different sea-ice habitats at the same relative densities as solitary adult females. Females keep nursing cubs with them for more than 1 year; hence the mean interbirth interval is 2 or more years. This results in a functionally skewed sex ratio, with fewer females available to breed in any one year than males, and in intrasexual competition among males for access to breeding females. Consequently, established dominance hierarchies among males are unstable, and wounding, scarring, and breakage of canine teeth are common; these are evidence of direct physical confrontations during the breeding season. Large body size is advantageous in these fights and this has resulted in one of the highest degrees of sexual dimorphism among terrestrial mammals. Because of the functionally skewed sex ratio and the shifting distribution of both females and males, however, even the largest male probably cannot be certain of locating a larger than average number of receptive females in any one breeding season.

3096 RAMSAY, M.A., and STIRLING, I. (1986)

Long-term effects of drugging and handling free-ranging polar bears; J. Wildl. Manage., Vol. 50, No. 4, pp. 619-626.

We evaluated the long-term effects of chemically immobilizing and handling free-ranging polar bears (Ursus maritimus) on body weight, reproductive effort, cub survival, and movements on land. Between 1967 and 1984, 2,246 bears (≥1 year old) were handled on 2,899 occasions, and 445 cubs-of-the-year were handled at least once. Bears were stratified for analyses by sex, age, reproductive status, and season. Comparisons of mean body weight were made between bears never before captured and those handled on at least 1 previous occasion. Significant differences ($P < 0.05$) were found only for 2 age, reproductive, or seasonal strata. These exceptions were 2-year-old males that were heavier on recapture and adult females with cubs in February through May that were heavier on 1st capture. Mean weights of 2-3-month-old cubs and mean litter sizes of 1-, 2-, and 3-year-old young did not differ between 1st-capture and recaptured mothers. However, recaptured adult females showed a consistent trend toward smaller litters and lighter cubs. Furthermore, 10 of 13 pregnant females handled at dens in October or November abandoned them soon after being captured and moved a median distance of 24.5 km. Consequently, our data suggest that chasing, capturing, and handling free-ranging polar bears may result in some long-term effects. Nonetheless, for most of the parameters we were able to measure and for most strata of bears, the long-term effects associated with capture are small and seemingly negligible in a time frame measured in months or years.

3097 RAMSAY, M.A., and STIRLING, I. (1988)

Reproductive biology and ecology of female polar bears (Ursus maritimus); J. Zool., Lond., Vol. 214, pp. 601-634.

Data on age-specific natality rates, litter size, interbirth interval, age of first reproduction, reproductive senescence, age of weaning and cub survival were determined for a free-ranging population of polar bears inhabiting Hudson Bay,

Canada, near the southern limit of the species range. Serum progesterone levels were also determined for females at different stages of their reproductive cycle to provide corroborative support for the reproductive parameters described. Animals were live captured using immobilizing drugs and each animal uniquely marked for future identification. First parturition occurred at four or five years of age and the age-specific natality rate increased with age until approximately 20 years, after which it dropped markedly. At least 40% of adult females displayed two-year interbirth intervals and 55% of cubs in their second year were independent of their mother. Mean size of cub litters in spring was 1.9 and 13% of litters had three or more cubs. The natality rate for 5-20-year-old females was estimated as 0.9, higher than that reported for any more northerly polar bear populations where two-year interbirth intervals are rare, fewer than 5% of yearling cubs are weaned and triplet litters occur with less than 1% frequency. Cub mortality was initially high and declined with age. Although cubs in western Hudson Bay were weaned at a younger age and a lighter weight than their counterparts in more northern populations, cub mortality rates were similar. The reason for the marked differences in reproductive parameters in the western Hudson Bay population is not known. We speculate that sea-ice conditions may be sufficiently different to allow weaned bears at a lighter body weight to hunt seals more successfully there than further north.

3098 RAMSAY, M.A., STIRLING, I., KNUTSEN, L.B., and BROUGHTON, E. (1985)

Use of yohimbine hydrochloride to reverse immobilization of polar bears by ketamine hydrochloride and xylazine hydrochloride; J. Wildl. Diseases, Vol. 21, No. 4, pp. 396-400.

Yohimbine hydrochloride (YH) effectively reversed the immobilizing effects of ketamine hydrochloride (KH) combined with xylazine hydrochloride (XH) in 48 wild polar bears (Ursus maritimus) handled in the summer. Single intravenous doses of YH ranging between 0.029 and 0.198 mg/kg resulted in a median time of 10 min (range: 1-123 min) to post-injection recovery from KH-XH immobilization. Convulsions and muscle twitching were observed in some bears after YH was administered and one death occurred. Median respiratory rate and heartbeat rate increased from 5 br/min to 12 br/min and 51 BPM to 79 BPM, respectively, soon after yohimbine was administered. The median time to recovery after KH-XH administration, including processing and handling time, was 113 min for bears administered yohimbine and 202 min for bears not administered YH. After YH-induced recovery, polar bears showed signs of reduced awareness and many remained recumbent for undetermined periods although they could coordinate movements, stand, and walk or run if disturbed. YH proved to be a useful antagonist to immobilization induced by KH-XH in a field situation.

3099 REED, A. (1986)

Eider ducks in Canada; Env. Can., Can. Wildl. Serv., Report Series No. 47, ed. A. Reed, 177 p.

Eiders occupied a special place in the hearts of the creators of the Migratory Bird Convention of 1916 between the United States and Great Britain on behalf of Canada. This report provides, simplicitly rather than explicitly, an account of the success of nearly 70 years of "special protection". The story is a patchy one. In the Maritimes and the St. Lawrence estuary, the Common Eider is again common in those places that meet its needs. In the Arctic it is far more numerous, yet perhaps doing proportionately less well. Eiders decreased because they were overexploited. In some northern areas they still, or again, are.

3100 REED, A., and CHAGNON, P. (1987)

Greater snow geese on Bylot Island, Northwest Territories, 1983; J. Wildl. Manage., Vol. 51, No. 1, pp. 128-131.

A survey of brood rearing and molting greater snow geese (Anser caerulescens atlanticus) was conducted on a 1,600-km^2 lowland plain on Bylot Island, Northwest Territories, Canada, during late July and early August 1983. The area was subdivided into 400 2- x 2-km plots, each classified as either dense, moderate, or sparse in terms of expected brood density. Eighty-three plots were surveyed from a helicopter and all groups of geese encountered were photographed for subsequent counting. The total population was 47,500 ± 16.3% (95% CI) geese of which 24,200 were goslings, 15,120 were adult parents, and 8,180 were subadults or unsuccessful breeders. Approximately 16% of the greater snow goose breeding population occurred on the study area, which makes it the most important breeding area for that race. The technique was efficient, accurate, and cost effective.

3101 RICHARDSON, W.J., FRAKER, M.A., WÜRSIG, B., and WELLS, R.S. (1985)

Behaviour of Bowhead Whales Balaena mysticetus Summering in the Beaufort Sea: Reactions to Industrial Activities; Biol. Conserv., Vol. 32, pp. 195-230.

Behaviour near actual and simulated activities associated with offshore oil exploration was compared with 'presumably undisturbed' behaviour. Underwater noise was monitored. Reactions to an approaching fixed-wing aircraft were frequent if it was at ≤305 m above sea level, infrequent at 457 m, and not detected at 610 m. When boats closed to within 1-4 km, surface/dive cycles became shorter and the whales swam rapidly away. Fleeing ceased when the vessel was a few kilometres beyond the whales, but scattering persisted

longer. Bow-heads did not move away from seismic vessels ≥6 km away, but subtle effects on behaviour sometimes were suspected. We found bowheads as close as 4 km from drillships and <1 km from a dredge, but drilling noise playback experiments provided evidence of an avoidance reaction. In general, bowheads showed considerable tolerance of ongoing noise from seismic exploration, dredging or drilling, but tended to react more strongly to rapidly changing situations such as an approaching boat or aircraft or a brief playback experiment.

3102 RICHARDSON, W.J., WÜRSIG, B., and GREENE, C.R., Jr. (1986)

Reactions of bowhead whales, Balaena mysticetus, to seismic exploration in the Canadian Beaufort Sea; J. Acoust. Soc. Am., Vol. 79, No. 4, pp. 1117-1128.

The behavioral reactions of bowhead whales to (1) distant seismic vessels not under our control, (2) a controlled approach by a seismic vessel, and (3) controlled tests with a single airgun were observed. (1) On 21 occasions in the summers of 1980-84, general activities of bowheads exposed to pulses of underwater noise (107-158 dB re:1μPa) from seismic vessels 6-99 km away were observed. Activities were indistinguishable from those without seismic noise; there was no detectable avoidance. Hints of subtle changes in surfacing, respiration, and diving behavior were unconfirmed, but were consistent with reactions to stronger noise pulses from closer seismic boats. (2) In a test with a full-scale seismic boat (30 airguns totaling 471, source level 248 dB re: 1μPa, closest point of approach = 1½ km), bowheads began to orient away when the airgun array began to fire 7½ km away. However, some whales continued apparent near-bottom feeding until the vessel was 3 km away. Whales were displaced by about 2 km. Reactions were not much stronger than those to any conventional vessel. (3) Tests with one 0.66-1 airgun showed that some bowheads move away from sources of strong seismic impulses even in the absence of boat noise, and that bowheads can detect the direction from which seismic impulses arrive. In general, bowheads exhibit avoidance reactions when they receive seismic pulses stronger than about 160 dB re: 1μPa. Evidence of reactions to lower received levels remains inconclusive.

3103 RUSSELL, D.E., and MARTELL, A.M. (1985)

Influence of the Dempster Highway on the activity of the Porcupine Caribou Herd; in Proc. 1st North Am. Caribou Workshop, Whitehorse, Yukon, Sept. 28-29, 1983, eds. A.M. Martell and D.E. Russell, pp. 22-26.

Potential detrimental effects of the Dempster Highway on Porcupine caribou were examined in relation to daily activity patterns, cratering activity, and short-term vehicular disruption. Paired field camps were established adjacent to the highway and outside of the highway corridor for the winters of 1979-80 to 1981-82. Data indicate that no significant energetic disruption could be attributed to the presence of the Dempster Highway under the traffic levels and snow conditions experienced during the study.

3104 SAKAGAMI, S.F., and TODA, M.J. (1986)

Some Arctic and subarctic solitary bees collected at Inuvik and Tuktoyaktuk, NWT, Canada, (Hymenoptera: apoidea); Can. Ent., Vol. 118, pp. 395-405.

Nine species of solitary bees are recorded from a northern area of Northwest Territories: Osmia inermis from tundra at Tuktoyaktuk, and Hylaeus ellipticus, Evylaeus comagenensis, E. borealis, Sphecodes aff. pusillus, Anthidium tenuiflorae, Megachile centuncularis, M. f. frigida, and Anthophora b. bomboides from the northern limit of subarctic forest at Inuvik. All represent the northernmost records of the species. Some chorological and ecological notes are added to.

3105 SHOSTAK, A.W., DICK, T.A., SZALAI, A.J., and BERNIER, L.M.J. (1986)

Morphological variability in Echinorhynchus gadi, E. leidyi, and E. salmonis (Acanthocephala: Echinorhynchidae) from fishes in northern Canadian waters; Can. J. Zool., Vol. 64, pp. 985-995.

Morphological variability of Echinorhynchus gadi, E. leidyi, and E. salmonis was evaluated from 30 collection sites in northern Canada. Nine new hosts were recorded. Mixed infections with the three species, in addition to their high morphological variability, made the identification of Echinorhynchus spp. from northern waters unreliable in the absence of information on morphological variability from local and geographically distant populations. Worm age, host species, and geographic location contributed to the variability of several taxonomically important characters: proboscis size and shape, hook size and number, body shape, and egg size. These characters had considerably greater variability and interspecific overlap in ranges than previously reported. Identifications were most reliable when based on gravid females. Individual males and immature females could generally be identified, with about 90% or greater reliability, using a multivariate comparison of proboscis measurements to a data set based on gravid females from the entire study area. Meristogram analysis revealed some intraspecific similarities and interspecific differences in proboscis hook shape but patterns varied geographically. While meristograms corroborated specimen identifications based on more comprehensive analyses, they were unreliable, when used alone, on Arctic and north temperate populations of echinorhynchids. Morphological variability between populations of Echinorhynchus spp. in different lakes was greater than could be accounted for by host species and the environment. It is hypothesized that this geographic variability may be a consequence of restricted gene flow

between isolated populations causing geographic isolation of morphological variants.

3106 SMITH, R.E.H., CLEMENT, P., COTA, G.F., and LI, W.K.W. (1987)

Intracellular photosynthate allocation and the control of Arctic marine ice algal production; J. Phycol., Vol. 23, pp. 124-132.

Ice algae are a case study in photo-autotrophic growth and metabolism under chronically low temperature and irradiance. We measured the allocation of ^{14}C-labelled photosynthate among major classes of intracellular carbon (low molecular weight compounds, or LMW; lipid; protein; and polysaccharide) and found light-dependent changes in allocation broadly similar to photo-adaptive responses known in phytoplankton at higher temperatures; average relative allocation to protein varied inversely (10-37%) and allocation to lipids and polysaccharides directly (10-23%, and 16-21%, respectively) with the sub-inhibiting irradiance levels we employed (3.5-33.0 $\mu E.M^{-2}.s^{-1}$). Unlike many observations at higher temperatures, ours indicated (on average) a large and light-insensitive allocation to LMW (ca. 40%) and a greater light-sensitivity in lipid than in polysaccharide allocation. At the higher incubation irradiances, resembling in situ levels typical of areas with little (0-5 cm) snow cover, allocation to protein was often low (10-13% compared to many observations of nutrient-sufficient or light-limited phytoplankton. Allocation to protein increased substantially (to ca. 40%) during a period of intensified tidal mixing, and assimilation numbers also attained a maximum at about the same time. Such dynamics show that the ice algae are not constrained to their often protein-poor allocation by the constantly low ambient temperature. Rather, they display marked shifts in metabolism consistent with major changes in light and inorganic nutrient supply, driven in part by the physical process of tidal mixing.

3107 SMITH, T.G. (1987)

The ringed seal, Phoca hispida, of the Canadian Western Arctic; Fish. and Oceans, Can. Bull. Fish. Aquat. Sci., Vol. 216, 81 p.

I studied ringed seals, Phoca hispida, during the years 1971 to 1983 from Holman in Amundsen Gulf, N.W.T., and several other localities in the southeastern Beaufort Sea. The highest densities of ringed seals (2.84/km^2) were found in Prince Albert Sound, Amundsen Gulf. Each year this becomes an area of good stable landfast ice which is consistently used as a breeding habitat. Age structure of the catches indicates segregation of older animals occupying fast-ice areas in the winter and spring, with all age classes being present in the summer open-water period. In the autumn, young-of-the-year and adolescents move west along the coast of Amundsen Gulf and southeastern Beaufort Sea. Seals tagged in this study were recovered as far west as Point Barrow, Alaska and Injun, Siberia.

3108 SMITS, C.M.M., and SLOUGH, B.G. (1987)

Abundance, distribution and occupancy of arctic fox (Alopex lagopus) dens in northern Yukon Territory; Govt. Yukon, Renewable Resources, Annual Progress Report, 28 p.

Presented are the results of an aerial stratified block sampling census of arctic fox dens on the Yukon Coastal Plain between the Babbage and Crow Rivers to the east and the Alaska/Yukon Territory boundary to the west. The study area was divided into a high density and a low density area based on the results of earlier surveys. In total 34.2% of the study area was censused. In the high density area, 23 sampling units, representing 90.4% of the stratum area were censused, whereas in the low density stratum, 21 sampling units representing 19.6% of the stratum area were censused. A sightability correction factor was derived from the proportion of known dens observed during the census and amounted to 77.8%. The estimate of the total number of fox dens in the study area, corrected for visibility bias amounts to 92 ± 19 (95% C.I.). Of 75 dens checked on the ground for use or occupancy by foxes, 19 (25.3%) were classified as active. At three of these (4.0%), arctic foxes were observed while at another one (1.3%) a red fox was observed. No sign of pups was seen at any of the dens. A total of nine dens have produced pups during the period 1984-1987. Further activities planned under the arctic fox project (IFA) are discussed.

3109 SMITS, C.M.M., SMITH, C.A.S., and SLOUGH, B.G. (1988)

Physical Characteristics of Arctic Fox (Alopex lagopus) Dens in Northern Yukon Territory, Canada, Arctic, Vol. 41, No. 1, pp. 12-16.

Physical characteristics of arctic fox (Alopex lagopus) dens on Herschel Island and the Yukon Coastal Plain, Yukon Territory, Canada, are described. The preferred den habitat on Herschel Island is characterized by moderately eroded, sloping, gullied terrain, where foxes select sandy erosional mounds for denning. The preferred habitat on the Yukon Coastal Plain is fluvial landforms, where foxes selected streamside cut-banks and occasional dunes for den location. Dens are generally associated with relatively warm, well-drained landscape positions. Burrow entrances are significantly oriented toward the south ($P < 0.0025$). Soils of dens are coarse textured, typically sandy loam to sand. Depth to permafrost is significantly greater under the den than at adjacent sites ($p < 0.02$). Certain unique soil profile characteristics, particularly the replacement of common cryoturbation (frost churning) features with those of zooturbation (faunal mixing) and the formation of humus-rich surface horizons, appear to be the result of denning activities by foxes. Observed differences in soil

temperature and depth to permafrost between den site soils and adjacent soils have likely been caused, at least in part, by denning activities.

3110 SMYTH, K.E., BARRY, T.W., and DICKSON, D.L. (1986)

Key areas for birds in coastal regions of the Canadian Beaufort Sea, Env. Can., Can. Wildl. Serv., Edm., internal report, 88 p.

The objective of this project was to develop a series of maps which identify the key areas for birds along the Beaufort Sea coastline. The primary purpose of the map series is to enable quick responses to questions which may arise in the event of an oil spill in the Beaufort Sea region. The maps and report will also be a useful reference for advising other agencies on such issues as regional planning and industrial development.

The study area for this project extends along the Beaufort Sea coastline from the Alaska-Yukon border to Baillie Islands off the tip of the Bathurst Peninsula. Emphasis was placed on the nearshore waters of the Beaufort Sea and the land that is below the storm tide line. However, information on birds using the offshore and the land above the storm tide line, within 2 km of the coast, was also reviewed and summarized.

3111 STELTNER, H., STELTNER, S., and SERGEANT, D.E. (1984)

Killer Whales, Orcinus orca, Prey on Narwhals, Monodon monoceros: An Eyewitness Account; Can. Field-Naturalist, Vol. 98, No. 4, pp. 458-462.

A first hand description is given of a herd or herds of several hundred Narwhals, Monodon monoceros, attacked by a herd of several tens of Killer Whales, Orcinus orca, in Eclipse Sound, Northwest Territories, in open water. The Killer Whales encircled the Narwhals by dividing into two groups which moved around the periphery of the prey animals in opposing directions. The attack by many killers at once then followed.

3112 STEWART, D.B., and BERNIER, L.M.J. (1984)

An aquatic resource survey of Melville Peninsula, Southampton Island, and the northeastern District of Keewatin, Northwest Territories; Env. Can. & Ind. & Northern Affairs Can., Land Use Infor. Series, Background Report No. 4, 144 p.

The Northern Land Use Information Series (NLUIS) is an environmental research and information mapping program for northern Canada, which provides a reconnaissance-level information base to facilitate regional planning and application of Territorial Land Use Regulations. The 1:250,000 scale maps produced include information on fish, wildlife, native land use, historical sites, proposed resource development activities, areas of conservation interest, and an ecological land classification. The 1983 survey encompassed Melville Peninsula, in the District of Franklin, and Southampton Island and the northeastern mainland, in the District of Keewatin, Northwest Territories. This report supplements comments on the 1983 maps by providing detailed information on the biology and utilization of fish species, and on aquatic invertebrates and water chemistry within the study area. It is one of an ongoing series of NLUIS reports detailing fisheries survey work in the Yukon and throughout the Northwest Territories.

3113 STEWART, T.G., and ENGLAND, J. (1986)

An early Holocene caribou antler from northern Ellesmere Island, Canadian Arctic Archipelago; Boreas, Vol. 15, pp. 25-31.

During the last glaciation of northern Ellesmere Island many areas remained ice-free. A caribou antler from deglacial-marine sediments in Clements Markham Inlet dates 8,415 ± 135 B.P. (S-2501). If locally derived it places caribou at the northern limit of their contemporary range at the onset of deglaciation in this area. Immediately to the south, on the Hazen Plateau, ice remained at its limit until c. 8,000 B.P. Therefore, this antler may indicate the presence of caribou during full glacial time.

3114 STIRLING, I., BROUGHTON, E., KNUTSEN, L.Ø., RAMSAY, M.A., and ANDRIASHEK, D.S. (1985)

Immobilization of polar bears with Telazol^{R} on the western coast of Hudson Bay during summer 1984; Env. Can., Can. Wildl. Serv., Progress Notes No. 157, 7 p.

Fifty-one polar bears were immobilized with Telazol^{R} along the western coast of Hudson Bay during summer. The bears had just come on to land from the annual ice and were very fat. Ambient temperatures ranged from about 5 to 20°C. Polar bears immobilized with a single dart received 8.06 ± 2.96 mg Telazol^{R}/kg. This was about 40% more than was required to immobilize polar bears in the fall, when they were much thinner. The drug acted quickly and, from the behaviour of a bear being induced, it was easy to determine when it was safe to approach. Heart and breathing rates were not depressed. Bears could thermoregulate while drugged, did not have convulsions, recovered quickly, and were not aggressive.

We conclude that Telazol^{R} is an outstanding drug for immobilizing polar bears.

3115 STIRLING, I. (1986)

Conservation of Polar Bears in Canada; in Proc. 40th Conf., International Union of

Directors of Zoological Gardens, Royal Society of Scotland, Edinburgh, pp. 43-47.

Research on polar bears in Canada is conducted in three major areas: population studies for management purposes; studies of distribution abundance, and critical habitat for environmental assessment; and basic research which enables us to better understand the polar bear in its habitat.

3116 STIRLING, I., and RAMSAY, M.A. (1986)

Polar bears in Hudson Bay and Foxe Basin: present knowledge and research opportunities; in Canadian Inland Seas, Chapter 17, ed. I.P. Martini, Elsevier Sci. Publishers B.V., Amsterdam, pp. 341-354.

The region of Foxe Basin, Hudson Bay, Hudson Strait and James Bay is a more or less self-contained inland sea and probably contains 3 to 5 relatively discrete subpopulations of polar bears (Ursus maritimus). However, despite the fact that about 200 polar bears are harvested from this area each year by Inuit and Indian hunters, our knowledge of the bears over the whole region is generally sparse and fairly localized in nature, both in terms of geography and subject matter. The principal reasons for this include the large size of the overall area, the relative inaccessibility of much of it (particularly offshore), and limited funding.

Scientific interest in the polar bears of this region encompasses a wide range of questions, of which research on population ecology for management is but one. For example, James Bay is home to the most southerly resident population of polar bears in the world. How have these bears adapted to cope with their environment, in comparison to their counterparts in the High Arctic, over 2000 km to the north, where factors such as mean temperature, day length, and the seasonal distribution of annual ice are so different? During the summer in Hudson Bay and James Bay, the open-water period is longer than in most of the rest of the Arctic and no ice-covered areas remain where polar bears can hunt seals, as some do further north. This means that most southerly-occurring polar bears spend protracted periods on land away from seals, yet they maintain a larger mean litter size and reproduce more frequently than any other population in the world. These and many other exciting questions invite investigation.

3117 STIRLING, I. (1986)

Research and management of polar bears Ursus maritimus; Polar Record, Vol. 23, No. 143, pp. 167-176.

Through the 1950s and 1960s, there was a marked increase in recorded numbers of polar bears being killed for their hides, giving rise to world-wide concern that the species might be endangered. At a meeting in Fairbanks, Alaska 1965, representatives of circumpolar arctic nations discussed conservation of polar bears and concluded that international coordination of research and management efforts was essential. Subsequent meetings of scientists engaged in polar bear research were organized every two years by the International Union for the Conservation of Nature and Natural Resources, facilitating exchanges of views and cooperation; as a result, in 1973 the International Agreement on the Conservation of Polar Bears and their Habitats was signed in Oslo, Norway. This paper describes some of the research and management undertaken in the years leading up to the agreement, and initiatives that are continuing because of it.

3118 STIRLING, I. (1988)

Attraction of polar bears Ursus maritimus to offshore drilling sites in the eastern Beaufort Sea; Polar Record, Vol. 24, No. 148, pp. 1-8.

Wildlife observations recorded at several offshore hydrocarbon exploration sites in the Beaufort Sea were examined to evaluate the hypothesis that polar bears Ursus maritimus are attracted to drill rigs, will be judged to represent a threat to humans there, and consequently will have to be deterred or destroyed. When polar bears came south with the pack ice in the autumn, they approached drillships or artificial islands, probably because they became curious or were attracted by unfamiliar smells. However, these bears did not usually remain in the area.

In late winter, when most of the natural leads are frozen, the movement of compacted annual ice from east to west past permanent offshore drill rigs creates open cracks on the downstream side. Because of the open water there, seals are more abundant, more accessible, or both, and bears are attracted because of better hunting conditions. In mid to late winter some bears may remain in the area for several days or longer while hunting seals. This positive reinforcement may lead these bears to be attracted to other offshore rigs in the future. In the last five years four bears attracted to offshore rigs have been shot; thus the hypothesis was found to be valid. To date, the population is not under threat, but this could change if the number of offshore drill rigs operating through the winter were to increase.

3119 STIRLING, I., ANDRIASHEK, D., SPENCER, C., and DEROCHER, A. (1988)

Assessment of the polar bear population in the eastern Beaufort Sea; Env. Can., Can. Wildl. Serv., Edm., Final Report to Northern Oil and Gas Action Program, 81 p.

The study area for this project is the Beaufort Sea east of 141°W and south of 75°N, and Amundsen Gulf. The objectives were to determine the present size of the population of polar bears in the study

area, and their vital parameters, compare these results with data collected in the 1970s, and, if possible, evaluate the effects of offshore hydrocarbon exploration and production on polar bears. From 1985 through 1987, 608 polar bears were captured. No deaths were caused by the drugging and handling procedures. Preliminary examination of movement data continue to indicate a separation of the polar bear population along the mainland coast from that on the west coast of Banks Island and Amundsen Gulf.

The average ages of males and females one year of age or greater were 7.36 ± 0.33 (SE) and 7.57 ± 0.38 (SE) for males and females respectively. Of the 290 males and 318 females handled, 73 (25.2%) and 86 (27.0%) were 10 years of age or greater. The mean litter size of cubs of the year caught between 1985 and 1987 was 1.84 ± 0.16 (SE). Natality rates of adult females (6-31 years old) fluctuated between 0.296 in 1986 and 0.519 in 1985. Differences in productivity appeared to be related to changes in ice conditions. These variations were similar to those recorded in the mid-1970s. Estimates of sex-specific annual survivorship, calculated from the combined 1985-1987 age structure, ranged from 87.5% to 88.5% when calculated by the Chapman and Robson (1960) method. Survival rates calculated from the age structure of a capture sample already include harvest mortality. Thus, the natural survival of some age and sex classes may be as much as 5% or higher. Population estimates for the whole of the study area ranged between about 1,300 and 2,100 polar bears, depending on the method. These values are similar to estimates made in the mid-1970s. A large portion of Amundsen Gulf, and part of the northern coast of Banks Island were not completely surveyed in some years. Overall, size and reproductive parameters of the population from 1985 through 1987 were similar to what they were in the mid-1970s. The present harvest is probably at maximum sustained yield.

The possible ways in which offshore development might impact on polar bears are discussed. No negative effects of development or increased hunting pressure were detected. Maternity denning appears to be increasing along the mainland coast.

3120 STRUZIK, E. (1987)

THE GREAT WANDERER: Tracking the Solitary Lord of the North; EQUINOX, January/February, 1987, pp. 18-32.

For four days, we had travelled across the Canadian Arctic sea ice between Cornwallis and Bathurst islands, stumbling through snowdrifts and shielding our faces against a biting wind. The trip, in theory, was a pleasure jaunt, a ski expedition to the magnetic north pole, but our joyful intent had been quickly eroded by cold temperatures, poor travel conditions and, most distressing sets of polar bear tracks that repeatedly crisscrossed our path. They were big tracks, some the size of two human hands, and they rattled us: obviously, the bears were with us, yet despite good visibility, we had yet to spot one. The question was not if we would see a polar bear but when and under what circumstances.

Then, on the fifth day, the silhouette of a bear emerged from an eerie, patchy fog that had materialized during the morning hours. With remarkable speed, the bear loped through the frozen landscape, appearing and then disappearing into the fog, playing a game of ghostly hide-and-seek among the large blocks of ice pushed up by the rising and falling tides of the ocean beneath us.

Initially, it seemed not to notice us, but within moments of our sighting it, the bear suddenly stopped and turned in our direction. Had it scented us? We scrambled toward shore and a high point of land for a better view. No longer so ghostlike, the bear appeared almost human as it reared up on its hind legs, stretching out a body that was larger than any I could have imagined.

As the bear approached, I quickly reviewed the three-tiered polar bear defence system suggested by a Northwest Territories biologist I had once interviewed. First, fire a blank to scare the bear; second, if it keeps coming, set off a smoke flare; and third, shoot a plastic nonlethal bullet at its rump. And then? None of us wanted to use live ammunition.

The blank had no visible effect on the bear's course, but as we prepared the flare, the bear abruptly veered off to follow a faint crack in the ice in search of blowholes and basking seals. For nearly an hour, we watched it - powerful, dangerous and undisputed - zigzag toward the horizon, growing fainter and fainter in the ice-crystalled haze.

3121 SUTCLIFFE, A.J. (1985)

On the track of Ice Age mammals; British Museum (Natural History), London, England; Henry Ling Ltd., Dorset Press, Dorchester, Dorset, 224 p.

For most people the idea that there was once an ice age is a familiar concept - a world covered in great sheets of ice, blizzards sweeping across barren wastes, cave men dressed in animal skins and huddled round open fires or trapping huge hairy mammoths. But is this an accurate or complete picture? What happened when the ice retreated and interglacial conditions prevailed? What caused such drastic climatic fluctuations? Fluctuations that are still having their effect today and will surely continue to do so possibly causing untold damage to future generations.

Taking as its central theme the mammals of the last two million years, this book investigates these problems by looking at the fossil and geological evidence - the diversity of species, plant remains, cave art, glacial processes, etc. and compares these to their modern-day equivalents.

Illustrated throughout with pictures from around the world, **On the track of ice age mammals** provides a fascinating and highly readable insight into a field of multi-disciplinary research that may have far-reaching implications for the future of mankind. It will appeal to a very wide audience but geologists, palaeontologists, biologists and climatologists will find it indispensable.

3122 TALARICO, D., and NOSSOP, D. (1986)

A three year summary of avifauna research on Herschel Island, an interim report for use in park management and interpretive programs; in 1986 Annual Report on Birds of Prey and Non-game Birds, Inventory, Population Studies and Management Projects; Govt. Yukon, Renewable Resources, pp. 81-153.

Herschel Island has been the focal point of man and nature for centuries. Traditionally a Thule Eskimo area, changes occurred in the late 1800's, when Herschel became a whaling community. The people of the area began to live a more trade oriented lifestyle, to which Herschel's wildlife became exposed. Whales, fox, caribou, bears and birds, in part make up Herschel's wildlife. Birds are most abundant, coming from places, as far away as, South America and Antarctica to breed, moult or feed on Heschel's shores and tundra.

Today Herschel Island is in the process of becoming a Yukon Territorial Park in order to preserve the wilderness and historical features of the island. The information in this report was collected for use in wildlife management and park interpretive programs. For the last 3 years (1984 to 1986), Yukon Government biologists have set out to determine the diversity, the abundance, and the breeding status of birds on Herschel Island.

3123 THOMAS, V.G. (1987)

Similar winter energy strategies of grouse, hares and rabbits in northern biomes; OIKOS, Vol. 50, pp. 206-212.

Neutral fat and protein reserves were measured in three species of grouse, cottontail rabbits, snowshoe hares and European hares collected during the mid to late winter period in their natural habitats. Neutral fat levels were measured in arctic hares from the Canadian high arctic during late summer. Sharp-tailed grouse, spruce grouse and ruffed grouse contained, respectively, 2.2, 2.3 and 1.0 g of fat per 100 g fat-free body weight, regardless of sex, year or location. Cottontail rabbits, arctic hares, snowshoe hares and European hares, had, respectively, 4.1, 2.5, 2.3-4.1 and 6.9 g of fat per 100 g fat-free body weight. The low values for fat and protein reserves are similar to those reported for other grouse and leporid species in different parts of North America and Scandinavia. Collectively they indicate that species in both taxa have little metabolic resistance to winter fasting and must feed regularly to maintain energy balance. Grouse, hares and rabbits in winter habitats share similar energetic tactics of acquiring small energy reserves, feeding regularly for short periods and emphasize energy conservation rather than energy acquisition. A theoretical model relates the size of energy reserves in these species to the probability and duration of fasts due to severe winter weather, the changing quality of diets, and the probability of predation while amassing reserves prior to winter and using them during winter.

3124 THOMAS, V.G., and MacDONALD, S.D. (1987)

The Breeding Distribution and Current Population Status of the Ivory Gull in Canada; Arctic, Vol. 40, No. 3, pp. 211-218.

Aerial surveys were conducted in the eastern Canadian High Arctic from 1982 to 1985 to determine the distribution and size of breeding populations of the ivory gull (Pagophila eburnea). The known Canadian population is confined to Ellesmere, Devon, Seymour, Baffin and Perley islands. Two major concentrations of ivory gull colonies exist, one among the granitic nunataks of southeastern Ellesmere island and the other on the sedimentary plateaus of the Brodeur Peninsula of Baffin Island. The size of breeding groups varies greatly from 4 to over 300 adult gulls. Breeding colonies are typified by their inland, remote and desolate locations and virtual absence of other animal species. We suggest that there is a single Canadian population of ivory gulls whose adult cohort contains over 2400 birds. The small number of leg band recoveries and retrapping of banded birds indicates that individuals can live at least 15 years. One-year-old ivory gulls were not seen at the colonies or on adjacent waters, and their location during summer remains unknown.

3125 THOMAS, V.G., and MacDONALD, S.D. (1987)

The Significance of Terrestrial and Marine Oases in the High Arctic; in Proc. Sym. on Arctic Heritage, eds. J.G. Nelson, R. Needham and Linda Norton, Aug. 24-28,1985, Banff, Alta., pp. 147-153.

3126 TROUBRIDGE, J.T., and PARSHALL, D.K. (1988)

A review of the Oeneis polixenes (Fabricius) (Lepidoptera: satyrinae) complex in North America; Can. Ent., Vol. 120, pp. 679-696.

North American species of the Oeneis polixenes complex are reviewed. Two new subspecies, Oeneis polixenes luteus and Oeneis polixenes woodi, as well as one new species, Oeneis philipi, are described from northwestern North America. Oeneis polixenes peartiae is synonymized with Oeneis polixenes subhyalina.

3127 WEAVER, P.A., and WALKER, R.S. (1988)

The Narwhal (Monondon monoceros L.) Harvest in Pond Inlet, Northwest Territories: Hunt Documentation and Biological Sampling, 1982-1983; Fish & Oceans, Fish. Aquat. Sci., Can. Manuscr. Rep. No. 1975, 30 p.

This report presents a harvest analysis for the 1982 and 1983 narwhal (Monondon monoceros) hunts in Pond Inlet, NWT. We describe the composition and distribution of the landed catch, provide loss rates for each hunt phase, and estimate the annual total kill. Loss rates are reported as a percentage of the total number of narwhal struck. Losses at the floe edge were 56% and 27% in 1982 and 1983 respectively. During the ice crack hunts, losses were 56% in 1982 and 12% in 1983. The 1982 open water hunt was separated into deep and shallow water hunting phases; the combined loss rate for these two phases was 42% of the total number struck. We estimate that 169 narwhal were killed in 1982 and that 193 narwhal were killed in 1983. Biological information collected during both years included measurements of body and tusk dimensions, blubber thickness, reproductive organs, and qualitative observations of stomach contents. These data are included as a contribution to the data base for narwhal frequenting northern Baffin Island.

3128 WINCHESTER, N.N. (1984)

Life histories and post-glacial origins of tundra caddisflies (Trichoptera) from the Tuktoyaktuk Peninsula, N.W.T., unpub. M.Sc. thesis, Dept. Biology, Univ. Victoria, 229 p.

Life histories, species composition and post-glacial origins of Trichoptera from the Tuktoyaktuk Peninsula, Northwest Territories were examined. Nineteen species were identified while eight others could not be identified to species. Eighty-two percent of this fauna represented new Canadian arctic reports and all species represented Nearctic range extensions. Sphagnophylas meiops, gen. et sp. nov. was discovered.

Time available for insect growth in arctic regions is short, normally confined from early June to late September. Life cycles were completed in temperatures that remained consistently above 0°C. For the remainder of the year complete freezing of the stream and shallow areas of the surrounding drainage basin occurred. Trichoptera overwintered in several larval instars and survived ice encasement. These larvae were probably freezing tolerant, although more than one mechanism may exist to allow survival at sub-zero temperatures.

Thawing, which began in mid-May, was completed by mid-June and created a mosaic of flooded lowland marsh. This continuous littoral zone, dominated by rooted macrophytes, provided large areas for caddisfly aggregations. A small portion of the total fauna resided in the stream channel. This limited stream habitat contributed to the exclusion of strictly lotic Trichoptera.

Life history information for 10 of 19 species suggested that all species have a one year life cycle. Adult emergence coincided with the onset of drought. Developmental rates and number of instars were constant among all species. Rates of increase varied between 1.13 and 1.44. All rates agreed with Dyar's Rule except that of Sphagnophylax meiops.

Three patterns of flight period were recognized, defined on the basis of flight duration. Flight periods did not show a progression towards short and highly synchronized emergence with increased latitude.

The systematic and biogeographic relationships within the Trichoptera of northwestern North America are affected by past glacial events. The post-glacial origin of this fauna is composed of three groups that included Trichoptera that spent the glaciation in (1) Beringia, (2) south of the ice sheets, or (3) both areas. The Beringian element can be subdivided into 3 groups based on species distributional patterns. Group A is found only in Beringia (in North America). Group B is Beringian and widespread in North America but absent in the Palearctic. Group C includes Amphi-Beringian species with Nearctic and Palearctic distributions. Populations may have split and be present in both areas simultaneously.

The probable post-glacial sources of this fauna are (1) Beringia, 47%; (2) south of the ice sheets, 23.5%; (3) both of these areas, 29.5%. The composition of the Beringian elements including those species thought to have re-colonized from both areas is: Group 1, 31%; Group 2, 31%, and Group 3, 38%.

This study establishes the fact that a diverse caddisfly assemblage exists in the low arctic. Species survive extended cold periods as well as periods of drought, and are able to complete their life cycle in one year. Beringia is considered an important source of the observed species diversity.

3129 WÜRSIG, B., DORSEY, E.M., FRAKER, M.A., PAYNE, R.S., RICHARDSON, W.J., and WELLS, R.S. (1984)

Behavior of bowhead whales, Balaena mysticetus, summering in the Beaufort Sea: surfacing, respiration, and dive characteristics; Can. J. Zool., Vol. 62, No. 10, pp. 1910-1921.

Surfacing, respiration, and dive characteristics are described for presumably undisturbed bowhead whales in the Beaufort Sea during August and early September 1980-1982. The interval between respirations (blow interval) was relatively constant during different activities such as skim feeding at the surface, social interactions, and feeding in the water column. Durations of adjacent

surfacings and dives were positively correlated, and number of blows per surfacing was correlated with duration of surfacing. Mean blow interval, number of blows per surfacing, duration of surfacing, and duration of dive were all greater in 1982 than in the previous 2 years, presumably because of increased feeding in the water column in 1982. Blow rates were lower in 1982 than in 1980-1981, possibly due to less socializing in 1982. There was a tendency for increased dive durations in deeper water, but the data were not consistent on this point. In general, calves exhibited short dives and surfacings, especially while nursing. Nursing mothers were inactive and had lower blow rates than other adults.

3130 WÜRSIG, B., DORSEY, E.M., FRAKER, M.A., PAYNE, R.S., and RICHARDSON, W.J. (1985)

Behavior of Bowhead whales, Balaena mysticetus, summering in the Beaufort Sea: a description, Fishery Bull., Vol. 83, No. 3, pp. 357-377.

Behavior of bowhead whales summering in the Canadian Beaufort Sea was observed from an airplane and occasionally from shore during 1980-82, mainly during August. Behavior varied between years. In 1980, whales alternated periods of socializing with periods of feeding in several different ways: near the bottom (as evidenced by surfacing with mud), in the water column (suspected during long dives), and skim-feeding at the surface. In 1981, more time was spent apparently feeding in the water column, with some socializing and skim feeding. In 1982, almost all activity appeared to be feeding in the water column. In 1980, most whales studied were in water only 10-40 m deep. In 1981, they were farther from shore and in >20 m depth, and in 1982 long (10-30 min) dives were common in depths of 40-600 m. Variability in distribution and behavior presumably was related to availability of prey.

Besides feeding and socializing, we saw sporadic bouts of aerial activity (breaches, tail slaps, etc.) and log play. During 1981 and 1982 we observed young-of-the-year calves apparently waiting at the surface while adults fed below. In 1982, two such lone calves played with debris in the water.

During near-surface skim feeding, whales often associated in V-shaped or echelon formations, with up to 14 animals staggered behind and to the side of each other, all moving in the same direction at the same speed, with mouths wide open. We hypothesize that such coordinated movement may increase the efficiency of feeding on concentrations of small invertebrates.

3131 WÜRSIG, B., DORSEY, E.M. FRAKER, M.A., PAYNE, R.S. and RICHARDSON, W.J. (1986)

Behavior of bowhead whales, Balaena mysticetus summering in the Beaufort Sea: a summary; Rep. Int. Whal. Commn., Special Issue 8, SC/A82/BW14, pp. 167-175.

The behavior of bowhead whales was studied in the Canadian Beaufort Sea during the summers of 1980-83 and this paper summarizes more detailed observations published elsewhere. Bowhead whales feed in the water column, at the bottom and at the surface. Surface feeding at times involves the whales moving in an echelon formation which probably is the result of cooperation between animals. Social interactions occur sporadically, but more towards the end of the summer. Respiration, surfacing and dive characteristics change with the different behaviors. Distribution of bowheads in the Beaufort Sea varies between years and it is probable that distribution and relative frequencies of behaviors are in large part determined by food availability.

BOTANY

3132 ALLAN, C., SCHIFF, S., PIERSON, D., ENGLISH, M., ECCLESTONE, M., and ADAMS, W.P. (1988)

Solifluction and its influence on vegetation and stream water chemistry in small permafrost basins, Axel Heiberg Island, N.W.T.; in Proc. National Student Conf. on Northern Studies, Assoc. Canadian Univ. for Northern Studies (ACUNS), eds. W.P. Adams and P.G. Johnson, November 18-19, 1986, Ottawa, Canada, pp. 230-252.

The chemistry of three ephemeral streams which drain into a small, naturally acidified lake located on Axel Heiberg Island (79°25'N, 90°35'W) in the Canadian Arctic Archipelago, was examined during the snowmelt in 1984 and 1985. These streams are typical of those which develop during the snowmelt season in the High Arctic. Their drainage areas range from 0.08 to 0.22 ha, they are situated in an area of continuous permafrost.

Spatial differences in stream water chemistry were large with average specific conductance values differing more than five fold (75-600 μS^{-1}) and pH values varying by more than 2.7 units (3.8-6.5) over a distance of less than 100 m. Soil stratigraphy generally consisted of a shallow, brown, poorly developed cryosol underlain by a grey-black, highly acidic cryosol that extended to the bottom of the active layer. Disturbance of the upper soil horizons by solifluction, which allowed meltwater to contact the lower soil horizon, appears to be responsible for the observed spatial variation in stream chemistry.

Preliminary analysis of vegetation data indicates coverage and species assemblage differences between solifluction scarred and unimpacted basins. Vegetated slopes appeared to export more nutrients (total phosphorus and total organic nitrogen), than non-vegetated slopes.

3133 BASINGER, J.F. (1987)

Fossil Flora of the Eocene Buchanan Lake Formation, Axel Heiberg Island, Canadian Arctic; Abstract In Program of Abstracts, GAC-MAC Joint Annual Meeting, Univ. Saskatchewan, May 25-27, 1987, Vol. 12, p. 23.

The Buchanan Lake Formation, of the Eureka Sound Group, is defined by Ricketts as synorogenic deposits that accumulated in isolated foredeeps during Eocene Eurekan deformation. Included is a thick sequence of conglomerates, sands and silts filling a depression on northeastern Axel Heiberg Island and appearing to have been largely unaffected by later tectonic activity. Within these deposits are the remains of a diverse macroflora, including numerous in situ stumps preserved as intact fossil forests. Preservation of plant remains within the silty, forest-bearing horizons is superb; wood has been mummified and retains its original woody texture, and litter of the forest floors is found in thick, leafy mats. Preliminary investigation reveals dominance of the floodplain by the taxodiaceous conifers, Metasequoia and Glyptostrobus, with associated Cercidiphyllum, ?birch, and Osmunda. Allochthonous deposits frequently contain cones and foliage of Pinus, Picea, Abies, Larix, Thuja, Ginkgo, Alnus, Fagaceae, Juglandaceae, and other deciduous angiosperms. Earlier assignment of these deposits to the Late Tertiary Beaufort Fm. was shown by Ricketts and McIntyre to be in error. Their interpretation of an Eocene age is in agreement with the current reassessment of the macroflora. The presence of unaltered wood and spruce cones has frequently been used as a basis for the recognition of Neogene sediments of the Beaufort Formation. The occurrence of unaltered remains in Paleogene sediments of the Buchanan Lake Formation introduces a cautionary note in such use of this type of fossil material.

3134 BASINGER, J.F. (1984)

Paleocene temperate floras of western and northern Canada; Abstract in Proc. Second Inter. Org. Paleobotany Conf., Edmonton, Alta., p. 5.

Temperate floras of Paleocene age are preserved in southern Saskatchewan and Alberta, Yukon, Northwest Territories, and the Arctic islands. Appreciation of diversity has been hampered by problems of plant classification and uncertainty in age determination. Palynological control and better definition of the Cretaceous/Tertiary boundary in western and arctic Canada has been of help. Paleocene floras of the Eureka Sound Formation, Ellesmere Island are of low diversity, with Metasequoia, Glyptostrobus, Cercidiphyllum, and birch? abundant. Here, as elsewhere in the temperate zone, the taxodioid conifers formed the coal forests. Northern Greenland, Spitzbergen, northern Alaska, northeastern Siberia and Ellesmere Island had comparable floras and were the northern most Paleocene lands. Small coal basins of central and southern Yukon preserve a variety of low diversity floras. In some cases assemblages are most similar to those of higher latitudes, in others there is greater similarity to Alberta/Saskatchewan floras. Variability in Yukon floras may result from climatic variation in time or space or peculiarities in structure of communities sampled. Numerous Paleocene floras occur in Alberta and Saskatchewan. These southern temperate floras are typically far more diverse than contemporaneous floras of the high latitudes; yet most northern forms are represented, indicating that a few extremely widespread species of broad climatic tolerance colonized the high latitudes. Floras of southern Greenland and southern Alaska, too, are diverse, and with southern Canadian floras represent the warmer temperate zones. An abundance of florules in the Ravenscrag Formation of Saskatchewan contributes to a better appreciation of Paleocene community structure, which will be important to our reassessment of diversity throughout the temperate regions of the Paleocene.

3135 BASINGER, J.F. (1985)

Early Tertiary temperate floras of western and northern Canada; Abstract in Proc. Can. Congress of Biology, London, Can. Botanical Assoc., Abstract No. CB11.01.

Fossil plants of Paleocene age have been recovered from coal-bearing rocks of southern Saskatchewan, Alberta, southern and central Yukon, the Mackenzie Valley of the Northwest Territories, and Ellesmere Island. These fossil assemblages represent early, temperate to cool temperate floras that flourished throughout western and northern North America about 60 million years ago. The current study represents one of the first investigations of these floras since early work associated with 19th Century Arctic expeditions. Throughout the temperate regions, lowlands, especially coal swamps, were dominated by Metasequoia and Glyptostrobus. These conifers, with the ubiquitous "Cercidiphyllum" complex, have become identified with fossil floras of boreal temperate zone. Other plants, such as Platanus, birch?, and Cupressinocladus (cedar) are minor constituents, but occasionally overwhelm florules. Azolla and "Trapa" are locally abundant and represent aquatic flora. Equisetum, ferns, including Osmunda, and angiosperms such as Paranymphaea and Vitis formed the understory of colonized open or disturbed habitats. Other taxa, including Ginkgo, Tapiscia, Zingiberopsis and many unidentified forms are minor components of many of the known floras. Early Tertiary temperate floras show some decrease in diversity northward, but for the most part are noted for their consistency. During this time a small number of taxa of remarkable climatic tolerance dominated the high northern latitudes.

3136 BASINGER, J.F. (1986)

Our 'tropical' Arctic; Can. Geographic, Vol. 106, No. 6, pp. 28-37.

Forest of massive stumps discovered in our polar region reveals the vastly different world of 45 million years ago.

3137 BASINGER, J.F. (1987)

High latitude vegetational changes of the Tertiary of North America; Abstract in Proc. XIV International Botanical Congress, Berlin (West), Germany; Changes of plant cover and environment during the Tertiary, Programme Div. 6: Environmental Botany, Abstract No. 6-02-1.

For over 100 years, existence of past polar climatic regimes amenable to forest growth at very high latitudes has been without doubt. Recent collections from the Tertiary, Canadian Arctic, provide parameters for climatic and vegetational changes. Paleocene polar regions of North America (>50°N) were clothed by deciduous forest remarkable for its uniformity and the broad ecological tolerance of principle constituents. The concept of arctic floristic heterochroneity is not supported by current work. Also, poleward leaf gigantism, as a product of low light levels, is placed in doubt. Of abundance, especially in lowland communities, are Taxodiaceae, "Cecidiphyllum", Betulaceae, Platanaceae, Juglandaceae, Ulaceae, and others. As evidenced by Eocene mummified plant communities of Axel Heiberg Island, members of the early polar flora persist in lowland and coal swamp environments, but more modern elements on the Pinaceae, Betulaceae, Juglandaceae, and Fagaceae are conspicuous in allochthonous deposits derived from surrounding habitats. Mixed coniferous forests, dominated by members of the Pinaceae, rise to prominence during the Miocene, coinciding with Neogene climatic deterioration and persisting in the Canadian Arctic until very near initiation of continental glaciation.

3138 BASINGER, J.F., and DILCHER, D.L. (1983)

Fruits of Cercidiphyllum from the early Tertiary of Ellesmere Island, arctic Canada, Abstract in Amer. J. Bot., Vol. 70, No. 5, p. 67.

Numerous clusters of follicles have been recovered from Paleocene shales of the lower Eureka Sound Formation, Fosheim Peninsula, Ellesmere Island, 79°47'N 85°6'W. Individual follicles are about 13 mm long and 2 mm wide, are sickle-shaped, and are arranged so that tips converge at the tops of the clusters. Clusters are globose, 15-20 mm in diameter, with a peduncle about 10 mm long. The peduncle branches a few times at the base of the cluster to produce about 15 follicles borne in a terminal position. Fruits had dehisced prior to fossilization; seeds have not been found. Dehiscence occurs on both ventral (toward center of cluster) and dorsal surfaces. The fruits are associated with a low diversity flora including leaves of Cercidiphyllum, Tilia?, Glyptostrobus, and Metasequoia. They are unlike the elongate, multifollicular axes typically attributed to early Tertiary (Paleocene) Cercidiphyllum. This fossil material from Ellesmere Island may represent a lineage more closely allied to the living species than the Cercidiphyllum recognized in more southerly, early Tertiary localities. It is particularly interesting that these compact fertile shoots are found at an earlier age in the high arctic area than at lower latitudes.

3139 BATTEN, D.S. (1987)

Plant communities and their microenvironments on the uplands surrounding the Alexandra Fiord Lowland (79°N), Ellesmere Island, N.W.T., Canada; unpub. M.Sc. thesis, Dept. Botany, Univ. Toronto, 234 p.

The vegetation of the uplands surrounding Alexandra Fiord Lowland (78°53'N; 75°55'W), Ellesmere Island, N.W.T., Canada was surveyed. Seven distinct plant community types were identified and described on these uplands. Principal Components Analysis (PCA) was used as an aid in separating and identifying the major vegetation units. These were found to be comparable to community types identified by other researchers studying the vegetation of the High Arctic. The microclimate of several vegetation stands representative of these plant communities was intensively studied.

Several environmental factors were considered to have an influence on plant community distribution on the uplands. These included: soil moisture gradient, macrotopography (a function of elevation, slope and aspect); soil organic matter content; total nitrogen; and available potassium. In their effects these and other factors were shown to be interdependent, creating a complex of environmental gradients. The Paleozoic outlier on the western plateau of Alexandra Fiord, although limited in size, was shown to have a major influence on plant community development and its floristics.

A total of 19 plant species were added to the Alexandra Fiord area flora including 3 vasculars, 10 bryophytes and 6 lichens.

The autecological study of the prominent upland species Luzula arctica clearly illustrated the limitation exerted by low soil moisture on leaf productivity. There was evidence that Saxifraga oppositifolia broke dormancy and initiated its reproductive cycle while still under snow. The two dominent upland vascular species Salix arctica and Dryas integrifolia initiated growth and entered their reproductive cycle shortly after snowmelt. The length of the species phenophases was not significantly affected by the timing of snowmelt.

The most contrasting microclimates of the major habitat sites were measured in the lowland. The ground surface and rooting zone temperatures of the xeric raised beach ridge were found to be the warmest while the hydric sedge meadow sites recorded the coolest. Surprisingly the microclimate of the upland study sites fell between these two lowland extremes. The major difference

between the Alexandra Fiord upland and lowland systems was seen in the length of the growing seasons rather than in microclimate differences.

The upland energy budget investigation showed very low Bowen ratios which is atypical of high arctic sites. The latent heat flux was shown to be more effective in removing heat from the upland surface. The lush Luzula-dominated community type was shown to be experiencing a radiative surplus by mid-season while the depauperate Dryas Barrens community type showed a radiative deficit.

The Alexandra Fiord upland vegetation included stands representative of the sedge meadow and Dwarf Shrub community types which are lush for such upland situations in the High Arctic. This lushness may be explained by the more favourable nutrient and microclimate conditions measured within the habitats of these community types.

3140 BERGSMA, B.M. (1986)

The effect of low temperature and continuous photoperiod on the growth of the potato (Solanum tuberosum) in the High and Mid Arctic, Northwest Territories, Canada; unpub. M.Sc. thesis, Dept. Botany, Univ. Toronto, 204 p.

The growth of early maturing potato varieties: Yukon Gold, Jemseg, Superior, Campbell-13, F72217, G581-25 and Serrana was evaluated in 1982 and 1983 at Alexandra Fiord (78°53'N, 75°55'W) Ellesmere Island and Rankin Inlet (62°45'N, 92°10'W) Keewatin District, Northwest Territories, Canada. Plant responses to bare tundra soil, plastic ground mulches and specially designed 3 m diameter, sun-heated, dome-shaped greenhouses were assessed to determine the biological feasibility of producing a crop of tubers using simple and appropriate low-cost technology. In bare soil where temperatures never exceeded 10°C, plants grew but rarely produced tubers: those grown under clear plastic mulch produced tubers with the earliest date of tuber initiation. Highest tuber yields of 350 g/plant (24 t/ha) were obtained in the greenhouses, especially when plants were grown in black plastic soil bags, or in a greenhouse that has insulation between the permafrost and the active soil layer. In a linear regression analysis, treatment temperature was shown to significantly influence the final tuber yield. The average temperature in the vented greenhouses during July was 25°C at noon and 15°C at midnight. Irradiance ranged from 400-1200 umoles/m2/s. Analysis of variance showed the production of tubers of all varieties grown under natural 24 hour photoperiod was significantly greater than that under an artificial 18 hour photoperiod. Flowering was most profuse for Jemseg and Serrana under the continuous light and for Superior and Campbell-13 under the 18-hour photoperiod. Stem elongation was greater in the 18-hour than the 24-hour photoperiod. The potatoes produced had acceptable culinary quality, dry matter content, and their use as seed tubers. The potential to produce potatoes under arctic conditions was demonstrated.

3141 BERGSMA, B.M., SVOBODA, J., and FREEDMAN, B. (1984)

Entombed Plant Communities Released by a Retreating Glacier at Central Ellesmere Island, Canada; Arctic, Vol. 37, No. 1, pp. 49-52.

The release of a dead but well-preserved high arctic plant community, entombed for about 400 radiocarbon years (WAT-778 and 789) under glacial ice at Twin Glacier, central Ellesmere Island (78°53'N), 75°55'W) is reported. Remarkably intact plants have been emerging from under the ablating front of this polar glacier which has been retreating for several decades at an average rate of 4.1 $m \cdot yr^{-1}$ over the last 22 years. The vegetation can be readily recognized as a Cassiope tetragona-Dryas integrifolia-dominated community, similar in species composition and cover to an extant Cassiope-Dryas community 200 m below the ablation front. The excellent preservation of the plants supports the thesis that polar glaciers are frozen to their bases, and hence their movements are by internal deformation rather than by erosive basal sliding.

3142 BOURGEOIS, J.C. (1986)

A pollen record from the Agassiz Ice Cap, northern Ellesmere Island, Canada; Boreas, Vol. 15, No. 4, pp. 345-354.

A continuous pollen record from the last glacial period to 100 B.P. was obtained from an ice core drilled in 1977 near the top of the Agassiz Ice Cap. Pollen concentrations are low (c. 15-173 grains/100 l) throughout the core and exotic pollen grains (from distant sources) dominate over regional pollen grains (from Ellesmere Island). The very low concentrations during the Wisconsinan glacial period and the early Holocene are attributed to the increased distance of potential sources as most of northern North America was ice-covered or supported tundra vegetation. An increase of exotic grains (mainly birch and alder) at c. 7,600 B.P. corresponds to the period of alder migration into the Low Arctic regions. The subsequent fluctuations of exotic pollen, especially the increase at c. 3,100 B.P., are unexplained at present. Regional pollen concentrations start to increase at c. 6,100 B.P. and a maximum concentration is reached at c. 3,100 B.P. The pollen record suggests that plant migration into northern Ellesmere was limited until 6,100 B.P., then increased gradually and continued to do so for about 1,000 years after the climate had started to deteriorate at about 4,000 B.P.

3143 BOURGEOIS, J.C., and KOERNER, R.M. (1985)

Pollen analysis as collected by the Transglobe Expedition; in Report on Scientific

Work of the Transglobe Expedition 1979-1982; ed. R. Fiennes, pp. 296-302.

The Transglobe Expedition took a series of snow depth measurements. These were taken by probing through the snow down to the underlying sea-ice surface. A location in the centre of a multi-year floe, preferably with a frozen melt-pool surface under the snow, was chosen. Ten probes were made over an area of several square metres. The distance from the sea-ice surface to the snow surface was recorded and the mean value for the location calculated. Because of loss of equipment snow density was not measured. However, the snow density of Arctic Ocean snow is reasonably well known so that values from previous work have allowed the snow mass accumulation at each location to be calculated.

The mean value of snow accumulation for the entire traverse between approximately 85°N on one side of the North Pole to 85°N on the other is 7 kg m^{-2}. If we consider that this accumulation represents the period from the end of the melt season (approximately the end of August) to the time of measurement then the annual snow accumulation becomes about 11-12 kg m^{-2} a^{-1}. These values show that the Arctic Ocean receives very little precipitation. Indeed, the amounts are comparable to those found in desert environments. We might compare them to the snow accumulation rates in the world's coldest desert, i.e. Antarctica. Central East Antarctica snow accumulation values average about 3 kg m^{-2} a^{-1} and the South Pole 8 kg m^{-2} a^{-1}. The lowest accumulation values for the Transglobe Arctic Ocean traverse lie midway between Northern Ellesmere and the North Pole. However, the high variability of the values (a real effect) and the effect of other variables such as the degree of terrain variability (where pressure ridges 'trap' drifting snow) do not allow us to determine whether this reflects the precipitation pattern. The higher accumulation regions around the periphery of the Arctic Ocean, caused by the land steering depressions along the land/ice interface, is not apparent. This is due to the fact that the measurements do not extend southward beyond 85°N.

3144 CHRISTIE, R.L. (1988)

Field studies at 'fossil forest' sites in the Arctic Islands; in Current Research, Part D, Geol. Surv. Can., Paper 88-1D, pp. 57-60.

Field studies continue at a recently discovered fossil wood locality on Axel Heiberg Island. Fossilized logs and stumps in the lower Tertiary Eureka Sound Group are known at widely scattered Arctic localities.

Alteration of the organic matter at the new site, however, is minimal and the site may be an important one in the study of plant remains.

3145 DOUGLAS, G.W., ARGUS, G.W., DICKSON, H.L., and BRUNTON, D.F. (1981)

The rare vascular plants of the Yukon; SYLLOGEUS, No. 28, Nat. Museum of Natural Sciences, 96 p.

For each of the 313 rare plants in the Yukon flora the following information is presented in the form of an annotated list: distribution in the Yukon and elsewhere, habitat, rare and endangered status in Canada and throughout the world, and other pertinent data. The listed species are those that are restricted to a small part of the territory or, if more widespread, they are rare wherever they grow. Many of these plants are endemic to the Yukon or to the unglaciated Yukon - Alaska region and emphasize the uniqueness of this region and its biological importance. Candidate species that, after study, were excluded from the list, are listed in Appendix 1 along with the reasons for their exclusion. Yukon distribution maps, based on a study of herbarium specimens, are included.

3146 EDLUND, S.A. (1986)

Vegetation-geology-climate relationships of western Melville Island, District of Franklin; in Current Research, Part A, Geol. Surv. Can., Paper 86-1A, pp. 719-726.

Both surficial geology and climate closely control plant assemblages on western Melville Island. Vegetation falls into two broad categories: calciphilous communities on weakly to moderately alkaline substrates, and acetophilic communities on acidic substrates. Superimposed on this lithological control is the control imposed by climate. The region is subdivided into five bioclimate zones including a newly defined one - Zone 0 - unvegetated areas recently emerged from under neoglacial ice and snow.

An unusually vegetation-rich zone (Zone 4) covers a significant area of western Melville Island, making it the richest area of the central and western Queen Elizabeth Islands, comparable to the flora and communities in the Fosheim Peninsula region of Ellesmere Island. This zone may represent a disjunct of Mid Arctic vegetation into the region generally considered to be High Arctic.

3147 EDLUND, S.A. (1986)

Modern Arctic vegetation distribution and its congruence with summer climate patterns; in Proc. Climate Change Impacts in the Canadian Arctic, Canadian Climate Program Workshop, March 3-5, 1986, Orillia, Ontario, ed. H.M. French, Atmospheric Environment Service, Downsview, Ont., pp. 84-99.

Impact predictions of climatic change on northern vegetation require an understanding of the dependence of natural ecosystems on the present climatic regime. The worldwide distribution of natural ecosystems, such as tropical rain forests, steppes, and deserts has been closely linked to regional climates. Less is known of the climatic controls on vegetation at high latitudes, although

increasing coolness of summer limits the abundance and presence of spruce and affects tree growth form. In general, climatic control over the distribution of plant communities in the treeless Arctic is poorly understood.

This paper explores some of the relationships between climate and vegetation in the boreal forest, and illustrates how trends in the boreal forest become even more accentuated in the Arctic. The distribution of several Arctic vascular plant species illustrates regional vegetation patterns that show congruence with regional climatic patterns. These regional vegetation patterns can be compared to patterns known to exist during the Holocene climatic optimum. This can be used to predict the impact of future climatic warming, consequent upon an increase in atmospheric CO_2. A contradictory model predicting vegetation response to climatic warming is also examined.

3148 EDLUND, S.A. (1986)

Common Arctic Wildflowers of the Northwest Territories; (Fleurs sauvages arctiques communes des Territoires du Nord-Ouest) in Land Around Us Series, Indian & Northern Affairs, Regional Communications Branch, Yellowknife, N.W.T.

The arctic environment is a harsh one, for the land is frozen for nine to ten and one-half months of the year. Even though there is 24 hour daylight during the melt period (arctic growing season) the temperatures are surprisingly cool. The mean temperature for July in the Low Arctic is between about 7.5°C and 10°C; in the High Arctic it is less than 5°C.

Arctic plants have adapted to these cool conditions, by adopting a prostrate form, or by protecting their buds by burying them in tufts or rosettes of leaves. Many have an insulating hairy or wooly cover to leaves, stems, buds or fruits. Some, like the arctic poppy and arctic avens track the sun - orient their flowers so that they always face the sun, making maximum use of the sun's heat.

3149 EDLUND, S.A. (1987)

Plants Living Weather Stations; GEOS, Vol. 16, No. 2, pp. 9-13.

Short, compact ground-hugging plants and a complete absence of trees tell us that the Canadian Arctic is cold. But these plants can tell us much, much more ...

3150 FRANCIS, J.E., and McMILLAN, N.J. (1987)

Fossil Forests in the Far North; GEOS, Vol. 16, No. 1, pp. 6-9.

Mummified tree stumps give scientists a glimpse of an ancient landscape in the High Arctic.

3151 FREEDMAN, B., SVOBODA, J., LABINE, C., MUC, M., HENRY, G., HAMS, M., STEWART, J., and WOODLEY, E. (1983)

Physical and ecological characteristics of Alexandra Fiord, a High Arctic oasis on Ellesmere Island, Canada; in Proc. Fourth International Permafrost Conf., July 17-22, 1983, Fairbanks, Alaska, pp. 301-304.

Physical and ecological features of an atypically lush high arctic lowland, on Ellesmere Island, are described. Site topography, moisture supply, drainage patterns and radiation input combine favorably to create a highly productive biological oasis amidst a polar desert setting. Growing season radiation and energy balance parameters were higher than those of sites at similar latitudes. Thirteen distinctive lowland plant communities were recognized and divided into a xeric-mesic to mesic lichen-heath-cushion plant dominated series associated with a seasonally discontinuous moisture supply, and a mesic to hydric sedge dominated series associated with a relatively continuous moisture supply. Community species composition, standing crop, and primary production reflected changes in habitat moisture conditions.

3152 GOULD, A.J. (1985)

Plant communities of the Lake Hazen area, Ellesmere Island, N.W.T., unpub. M.Sc. thesis, Univ. Toronto, 325 p.

The vegetation and floristics of two sites on northern Ellesmere Island, Lake Hazen and Piper Pass were examined during the course of this study. Quantitative methods were used to describe the vegetation of the two sites, the stands of which were then subjected to an ordination procedure, Principal Components Analysis.

Several environmental and edaphic parameters were measured in conjunction with the vegetation. These were then superimposed onto the ordination to determine the factors controlling the distribution of the vegetation with the two study areas. In addition, microclimatic stations were established at the Lake Hazen site to determine differences in temperatures between the main community types.

It was found that moisture was the main factor determining the distribution of the vegetation although a complex of environmental parameters, including substrate type and texture also had an influence.

The vegetation of the two areas was arranged along a continuum. There was a gradation of one stand into another along an environmental gradient. The determination of distinct plant communities based on species dominance could not be achieved. However, an incorporation of habitat into the description facilitated recognition of vegetation

types (communities). The communities that were recognized were comparable to those delineated for other areas in the High Arctic.

The vegetation and floristics of the two sites were quite different even though they were in close proximity to each other and were part of the same geological region. The glacial history and microclimate of the two sites however, is thought to be different. The Piper Pass site was presumably not glaciated based on geomorphological evidence but it had less than one half of the flora of the Lake Hazen area which was covered by ice during the Wisconsin period. It is generally thought that part of northern Ellesmere Island was a refugium during this period. However, there were no endemic of disjunct populations of vascular plants in either of the two study sites and thus the botanical evidence for this hypothesis remains inconclusive. The depauperate nature of the Piper Pass flora in comparison to Lake Hazen, can be explained by a more severe climate and less diversity of habitats.

Four vascular taxa were added to the flora of Lake Hazen during the course of this study, three of which represent northern range extensions. The flora of Piper Pass site was previously undocumented.

The vegetation of the lowland of the Lake Hazen study area has been in existence since the time of deglaciation (8000 y BP). Examination of a deposit of peat in the Skeleton Creek valley of the Lake Hazen study area revealed that wet sedge meadows similar in composition to those of the present day were growing in the lowland since this time.

The vegetation of the two sites was also very different with only the plant communities associated with the screen showing similarities. There was a predominance of graminoid dominated communities at the Piper Pass site while stands dominated by Dryas were most common at Lake Hazen. However, the vegetation of Piper Pass was similar to that of a system of passes on the windward side of McGill Mountain, outside the Lake Hazen study area.

3153 HART, G.T. (1988)

Dryas integrifolia and its habitat diversity in the Canadian High and Low Arctic; unpub. M.Sc. thesis, Univ. Toronto, 207 p.

This autecological study documents the characteristics of habitats where Dryas integrifolia occurs, and the affinity of Dryas phenotypic expression to particular habitat characteristics. Research was conducted at Alexandra Fiord, Ellesmere Island, N.W.T. (79°N) and Churchill, Man. (59°N) to study D. integrifolia within and between the latitudinal range extremes. Within the two locations, a total of sixteen study habitats were chosen to represent a range of moisture regimes, microthermal environments, soil conditions, and plant communities containing D. integrifolia. Habitat characteristics measured were: date of snowmelt, development of the active layer, seasonal ground temperature, soil-air microthermal profile, gravimetric and volumetric soil moisture, soil texture and nutrient chemistry, and species cover and prominence in the plant community. Dryas characters measured were: date of foliage virescence, development of terminal shoots, mature leaf length, width, and biomass, aboveground biomass partitions of the whole plant and its cushion/mat size, phenologic progression, pedicel length in flower and fruit, anatomical flower abnormalities, success of fruition, and susceptibility to use by other species.

Dryas integrifolia occurred throughout the wide range of soil moisture regimes in the terrestrial habitats of the Alexandra Fiord lowland, and was common in the vicinity of Churchill in xeric and mesic regimes, but had restricted distribution in hydric environments and under forest canopy. In the Canadian Arctic, this plant cannot be considered a calcicole as it also grows in acid soils. The Dryas cushion growth form was associated with greater retention of dead leaves in the High Arctic. Cushion plants also developed a positive thermal increment over the surrounding ground surface in sunny weather. In the Low Arctic, D. integrifolia cushions/mats in established habitats were smaller ($\bar{x}$=258cm^2) than those measured in the High Arctic ($\bar{x}$=603cm^2). Mats in pioneer situations at Churchill reached extreme sizes up to 9505 cm^2. Phenologic progression of Dryas varied according to the date of snowmelt and initiation of growth. The period of active growth, ca. 45 to 50 days, remained similar for both locations. At Churchill, a greater number of leaves were produced per terminal shoot. Mature leaf length, width, and biomass, and flower and fruit pedicel length, were significantly greater in the Low Arctic than those measured in the High Arctic. There is evidence that two distinct ecomorphs of the species are involved. Leaf size and pedicel lengths also varied among the study habitats. Fruiting success varied among study habitats but not overall between locations. Aborted fruition appears to be induced intrinsically by the plant, as it could not be related to frost or herbivory. Dryas integrifolia responds especially strongly to ambient levels of moisture, shading, or disturbance as causes for its interhabitat character variation.

3051 HENRY, G., FREEDMAN, B., and SVOBODA, J. (1986)

Survey of Vegetated Areas and Muskox Populations in East-Central Ellesmere Island; Arctic, Vol. 39, No. 1, pp. 78-81.

3154 HENRY, G.H.R., FREEDMAN, B., and SVOBODA, J. (1986)

Effects of fertilization on three tundra plant communities of a polar desert oasis; Can. J. Bot., Vol. 64, pp. 2502-2507.

Three plant communities studied at a high arctic oasis on Ellesmere Island responded to nutrient addition. Response to nitrogen was greatest in the driest community and weaker in the more mesic and wet-mesic communities. Nutrient addition resulted in (i) increased inflorescence densities of dicotyledonous and certain graminoid species; (ii) increased tiller densities of wet sedge species; and (iii) increased net production of graminoids and forbs at high rates of application, and in some dwarf shrubs at lower rates. These results parallel those of studies at lower latitudes in the Arctic, and support the hypothesis that arctic ecosystems are typically oligotrophic.

3155 HENRY, G.H.R., and SVOBODA, J. (1986)

Dinitrogen fixation (acetylene reduction) in High Arctic sedge meadow communities; Arctic & Alpine Res., Vol. 18, No. 2, pp. 181-187.

Dinitrogen fixation rates were investigated, using an acetylene reduction technique, in intact soil cores of sedge meadow communities at two high arctic sites on Ellesmere Island: Alexandra Fiord (78°55'N) and Sverdrup Pass (79°10'N). Acetylene reduction activity (ARA) showed increasing rates from snowmelt until late July, followed by a decline in the late growing season. The majority of ARA occurred in the upper 5 cm of the soil. Acetylene reduction activity on the soil surface constituted 35 to 65% of seasonal mean ARA. Blue-green algae (especially Nostoc spp.) were considered the major N_2-fixing agents in the studied sites. There was little difference in ARA between Sverdrup Pass and Alexandra Fiord, despite differences in herbivore utilization; Alexandra Fiord was a nongrazed lowland, while Sverdrup Pass was heavily grazed by muskoxen. In the Alexandra Fiord meadows, ARA was equivalent to fixation rates of 65 to 104 mg N m^{-2} yr^{-1}, and in the Sverdrup Pass meadows to 90 mg N m^{-2} yr^{-1}. At Alexandra Fiord, dinitrogen fixation was estimated to account for 65 to 80% of the total nitrogen input to the sedge meadow systems, with the balance coming from precipitation.

3156 HUTCHISON-BENSON, E., SVOBODA, J., and TAYLOR, H.W. (1985)

The latitudinal inventory of ^{137}Cs in vegetation and topsoil in northern Canada, 1980; Can. J. Bot., Vol. 63, pp. 784-791.

The latitudinal distribution of fallout ^{137}Cs in Canada has been determined along a transect extending from 50° to 82° N in 1980. The ^{137}Cs content of lichens, bryophytes, and cushionlike vascular species was measured at 16 sites between Brandon, Manitoba, and Alert, Ellesmere Island. Lichen species were shown to be the most effective biological monitors of ^{137}Cs deposition because of their specific morphology, longevity, and slow growth rates. Dry, exposed ridges were the sites of the highest ^{137}Cs retention by plants. ^{137}Cs levels in vegetation followed a bell-shaped distribution along the transect and the maximum accumulation was measured in samples collected between 60° and 70°N (10 nCi m^{-2} at 63°N) (1 Ci = 37 GBq). This distribution is the combined result of the original latitudinal deposition of ^{137}Cs, the expired portion of its physical half-life, and the efficiency of biotic and abiotic removal processes along the studied corridor. It is suggested that the long-term implications of ^{137}Cs in the northern food chain ought to be followed and studied more closely in the light of the data presented.

3157 MacDONALD, G.M., and RITCHIE, J.C. (1986)

Modern pollen spectra from the western interior of Canada and the interpretation of Late Quaternary vegetation development; New Phytol., Vol. 103, pp. 245-268.

The pollen spectra obtained from 127 lake sediment surface samples from the western interior of Canada are examined. Principal components biplots and discriminant analysis are used to investigate the correspondence between modern pollen rain and major vegetation zones in the study area. It is demonstrated that the major vegetation zones in the western interior of Canada can be distinguished on the basis of their modern pollen rain. Principal components biplots and discriminant analysis are also used to compare late Quaternary fossil pollen assemblages from lakes located near the southern and northern periphery of the modern boreal forest with the modern pollen spectra. The results suggest that the late Pleistocene and early Holocene pollen spectra from the southern and northern periphery of the boreal forest lack modern analogues in the western interior of Canada. The northern and southern boundaries of the boreal forest were located north of their modern positions during the mid Holocene. Vegetation developed and responded to mid Holocene climatic change at different rates at the two sites. Modern vegetation conditions were established at both sites between 5000 B.P. to 3000 B.P. Vegetation has remained relatively stable during the last three thousand years.

3158 MATTHEWS J.V., Jr., MOTT, R.J., and VINCENT, J-S. (1986)

Preglacial and interglacial environments of Banks Island: pollen and macrofossils from Duck Hawk Bluffs and related sites; Géographie physique et Quaternaire, Vol. XL, No. 3, pp. 279-298.

Sediments ranging in age from Tertiary to Late Quaternary are exposed at Duck Hawk Bluffs near Sachs Harbour on Banks Island (NWT). Fossil pollen and macrofossils of plants and arthropods from various nonglacial sediments at Duck Hawk Bluffs and related sites on Banks and Victoria islands make it possible to infer some of the climatic/biotic changes during that time span. At the time of deposition of the Miocene-Pliocene Beaufort Formation, southern Banks Island suppor-

ted a rich coniferous forest, containing several species of conifers and various hardwoods. An upper member of the Beaufort Fm. is characterized by a more depauperate coniferous forest assemblage, yet still contains plants now foreign to the entire NWT. The late Tertiary/early Quaternary Worth Point Formation was deposited when larch-dominated forest-tundra characterized southern Banks Island. Larch may have grown on the island during the following Morgan Bluffs Interglaciation (>730 ka), but in other respects the flora and fauna of that time seem to have been low Arctic in character. Similar conditions existed during the Cape Collinson Interglaciation (= Sangamon), though by that time, coniferous trees had definitely disappeared from the island.

3159 MATTHEWS, J.V., Jr., (1987)

Plant macrofossils from the Neogene Beaufort Formation on Banks and Meighen islands, District of Franklin, in Current Research, Part A, Geological Survey of Canada, Paper 87-1A, p. 73-87.

This report lists plant macrofossils representing at least 95 vascular species, from the Neogene Beaufort Formation on Banks and Meighen Islands. Among the specimens are those such as Epipremnum and Aracispermum that have not previously been reported from North America and many others (e.g., Cleome, Polanisia, Teucrium, Physocarpus), that presently occur far to the south of the Northwest Territories.

On Meighen Island at approximately 80°N, the Beaufort Formation is probably no younger than early Pliocene and may be as old as middle Miocene, yet its content of plants, such as Saxifraga oppositifolia, Oxyria digyna and Dryas integrifolia, plus other characteristics of the flora and insect fauna show that it represents a forest-tundra environment. If so, some form of tundra probably existed around the Arctic basin for much of the Pliocene. This has implications for the evolution of the existing lowland arctic flora and fauna.

3160 MAWSON, B.T., SVOBODA, J., and CUMMINS, R.W. (1986)

Thermal acclimation of photosynthesis by the arctic plant Saxifraga cernua; Can. J. Bot., Vol. 64, pp. 71-76.

The thermal acclimations of net photosynthesis, dark respiration, and photorespiration have been studied in the arctic plant Saxifraga cernua. The gas exchange of whole plants grown to maturity under different temperature regimes was analysed for individual plants transferred from (i) 10 to 20 (referred to as high-temperature acclimation) and (ii) 20 to 5°C (low-temperature acclimation). High- and low-temperature acclimation resulted in shifts of the leaf temperature optimum for net photosynthesis of whole plants in the direction of the new growth temperature. That the acclimating temperature directly affected the photosynthetic apparatus was indicated by (i) changes in the optimum temperature for gross photosynthesis of whole plants and (ii) a change in the oxygen sensitivity of net photosynthesis after acclimation to a new growth temperature. The change in the optimum temperature for net photosynthesis was also due, in part, to altered dark respiration rates which increased during acclimation to low growth temperatures. These results suggest that such acclimation in arctic species like S. cernua arose as a result of the selective pressure of fluctuating temperatures which are experienced during the growth season to maximize annual growth under arctic and subarctic conditions.

3161 McANDREWS, J.H. (1984)

Pollen Analysis of the 1973 Ice Core from Devon Island Glacier, Canada; Quaternary Res., Vol. 22, pp. 68-76.

Meltwater from a 299-m-long ice core was filtered and analyzed for fossil pollen and spores. Pollen concentration was higher in the late Holocene and interglacial intervals (ca. 7 liter $^{-1}$) than in the early Holocene and Wisconsinan (ca. 1-2 liter^{-1} ones. The late Holocene and interglacial assemblages were dominated by Alnus (alder), whereas the early Holocene and Wisconsinan ones were dominated by Betula (birch) and Artemisia (sage). During the Holocene and probably the last interglaciation, most of the pollen and spores were blown a minimum of 1000 km from low arctic shrub tundra and adjacent subarctic Picea (spruce) forest; these areas were dominated by the arctic air mass during the summer pollinating season. During the Wisconsinan-early Holocene, glacier ice and arctic air were more widespread and pollen sources were more distant; thus, at this time relatively little pollen was incorporated into the ice.

The Devon ice-core data suggest that there should have been pollen in the continental ice sheet of Wisconsin time. When the ice sheet retreated this pollen would be carried by meltwater and redeposited with silt and clay together with contemporary pollen, producing an ecologically anomalous assemblage.

3162 McIVER, E.E., and BASINGER, J.F. (1988)

Early Tertiary fossil cedar of the Canadian High Arctic; in Proc. National Student Conf. on Northern Studies, Assoc. Canadian Univ. for Northern Studies (ACUNS), eds. W.P. Adams and P.G. Johnson, November 18-19, 1986, Ottawa, Canada, pp. 362-367.

Recent collections of plant megafossils from Ellesmere and Axel Heiberg islands are contributing to our understanding of early Tertiary floras of northern Canada. Of particular interest is the recovery of remains, both leafy branches and seed cones, of cedars from 60 million year old sediments of Ellesmere Island. Since taxonomy of modern conifers is based primarily upon reproduc-

tive features, the discovery of seed cones is significant. Fossil foliage and cones of the cedar resemble most closely those of Thuja plicata, the western red cedar of the Pacific coast. Unlike present vegetation of Canada, with arctic through temperate zonation, early Tertiary vegetation appears to represent a more cosmopolitan temperate geoflora. Extensive forests of Metasequoia (dawn redwood), Glyptostrobus (swamp cypress), Cercidiphyllum (katsura), and birch? covered much of Canada from the southern border to Ellesmere Island. In addition to these four nearly ubiquitous taxa, our collections reveal associated forms including ferns and members of the sycamore, walnut, oak, linden, and other families. Continuing work on the fossil plants of northern Canada is increasing our appreciation of diversity and distribution of early temperate floras, and helps us to understand the origin and evolution of the modern floras of Canada.

3163 NEARING, M. (1986)

Sylvia Edlund - fun in a cold climate; Youth Science News, Vol. 16, No. 1, p. 15.

Spending your summer in one of Canada's northern-most regions isn't everyones idea of a good time, but botanist Sylvia Edlund says she doesn't remember ever not wanting to do anything but that - and its lots of fun!

3164 PARMELEE, J.A., and GINNS, J. (1986)

Parasitic microfungi on vascular plants in the Yukon and environs; Int. J. Mycol. Lichenol., Vol. 2, No. 2-3, pp. 293-347.

This flora concentrates on the host plants and geographic distribution of parasitic microfungi in the Yukon and environs. It is the most comprehensive evaluation of Yukon fungi to date and includes brief descriptions, notes on life cycles, ecological data and a host index. In all 283 species and subspecific taxa are recognized. Thirty-one are new records for the Yukon: Albugo cruciferarum, Anthracoidea aspera, Chrysomyxa monesis, Exobasidium cassandrae, E. cassiopes, E. karstenii, Glomopsis corni, Melampsora hirculi, Meliola nidulans, Mycosphaerella cruciferarum, M. populicola, Peronospora lepidii, Phyllosticta ferax, Placuntium andromedae, Puccinia aberrans, P. acrophila, P. adoxae, P. agroseridis, P. codyii, P. grindeliae, P. grumosa, P. heucherae var. minor, P. polygoni-amphibii, P. retecta, P. ustalis, Ramularia delphinii, R. rosae, Septogloeum hedysari, Septoria alni, S. kalmiaecola, Uredo beringianum, and Ustilago violacea.

3165 PEARCE, C.M., and CORDES, L.D. (1988)

The Distribution and Ecology of Water Horsetail (Equisetum fluviatile) in Northern Wetlands; J. Freshwater Ecology, Vol. 4, No. 3, pp. 383-394.

The distribution of Equisetum fluviatile on the Mackenzie Delta, N.W.T., Canada was examined between 1981 and 1987. E. fluviatile occupied mineral and organic substrates on the lower shorelines of stable channels and lakes that were flooded for 1 to 3 months during the growing season, and received 1 to 15 cm annual deposits of silty alluvium. The distribution of E. fluviatile in the tundra of the outer delta (north of 69 degrees latitude) was patchy and restricted to infilling inter-levee basins. Sexual reproduction was not observed during the study; E. fluviatile propagated and colonized new sites by the production of annual stems from underground rhizomes and dispersal of plant fragments during ice breakup flooding and muskrat grazing. Natural proliferation of stem fragments was observed, but the propagules did not survive.

3166 RITCHIE, J.C. (1974)

Modern pollen assemblages near the arctic tree line, Mackenzie Delta region, Northwest Territories; Can. J. Bot., Vol. 52, pp. 381-396.

Samples of surficial lake sediment and of moss polsters from 39 sites in the forest-tundra transitional area immediately east of the Mackenzie Delta, Northwest Territories, were investigated palynologically. Lake sediment samples within the forest and tundra regional vegetation zones are constant in pollen frequencies, but forest-tundra sites are very variable. Forest site spectra are composed of just over 50% arboreal types (spruce, 25-30%; birch, 30%), with 30-40% alder pollen. Tundra spectra have 60-70% non-arboreal types, and 10-15% each of alder and spruce. Forest-tundra values are variable generally lying between the forest and tundra proportions. Polster samples show as much variability within as between regions, because of local effects. Polster samples indicate local community composition with the regional pollen rain variably masked by the local elements.

3167 RITCHIE, J.C. (1976)

The Campbell Dolomite Upland Near Inuvik, N.W.T. A Unique Scientific Resource; Musk-Ox, Vol. 18, pp. 70-75.

The Campbell Dolomite Upland, comprising less than 0.01 per cent of the Mackenzie River basin, is unique in its scientific attributes. It has its own distinctive tectonic style; it is the only outcrop area of the Aklavik Arch in the Mackenzie River basin. The Precambrian, early Palaeozoic, and late Mesozoic sedimentary rocks have produced structural and chemical characteristics of primary significance in determining unique and rare biological phenomena. Arctic-alpine plants (some endemic to Megaberingia, others to northwest North America) occur in unstable habitats. Rich assemblages of arctic-alpine calciphiles occur, and the vegetation, undisturbed by fire for several centuries, provides several excellent examples of

rare communities. At least one notable member of the fauna is rare and is on the 'endangered species' list. An unusual meromictic lake has provided an unprecedented stratigraphic record of the vegetational and environmental history of the area. The area is unrivalled as a natural laboratory that is accessible for teaching and research in several branches of the natural sciences. However, current and apparently uncontrolled activities are accelerating the disruption of the area; if unchecked they will quickly render it useless for science.

3168 RITCHIE, J.C. (1979)

Towards a Late-Quaternary Palaeoecology of the Ice-Free Corridor; Can. J. Anthropology, Vol. 1, pp. 15-28.

The palaeoecology of the area known as the ice-free corridor is as poorly understood and documented as the geological evidence that there was in fact such an area. In the northern, Beringian portion the full-glacial (maximum 18,000 BP) was characterized by impoverished, tundra communities reflecting an environment colder, drier and less productive than during the Holocene and present-day. Most sites of greater apparent age (Middle Wisconsin), while they have yielded large numbers of vertebrate fossils, either lack stratigraphic context entirely or have stratigraphy of uncertain age and provenance. There is fragmentary evidence for Middle Wisconsin interstadial episodes that supported productive boreal woodland ecosystems.

3169 RITCHIE, J.C. (1982)

The modern and Late-Quaternary vegetation of the Doll Creek area, North Yukon, Canada; New Phytol., Vol. 90, pp. 563-603.

The modern vegetation of the mountainous Doll Creek region consists of tundra on surfaces above roughly 700 m elevation and spruce woodlands on lower slopes and valleys. Ordination of quadrat cover data by detrended correspondence analysis displays the characteristics and relationships of the vegetation. Tundra on non-calcareous parent materials is distinctive, dominated by Betula glandulosa, Arctostaphylos alpina, Ledum decumbens and Salix arctica. Limestone ridge surfaces, by contrast, support a tundra dominated by Dryas intergrifolia, Carex scirpoidea and Cetraria species; lower slopes on limestone are dominated by a Dryas-Cassiope-Tomenthypnum cover which also characterizes the ground vegetation of Picea glauca woodlands on lower surfaces. Bottomland mires are dominated by Picea mariana-Sphagnum woodlands and moraines support a Picea mariana-Betula glandulosa-ericad community. Larix laricina shares dominance with Picea glauca at treeline on northwest-facing gulley surfaces where deep and persistent snow appears to be important.

A detailed pollen analysis of one site, using percentage and influx diagrams, running means of influx of the main taxa, and a pollen influx-vegetation representation calibration method, reveals that immediately following the maximum of the latest glacial cycle (18 000 B.P.) the area supported a sparse, unproductive herb tundra on the lower montane slopes and a sedge-grass marsh complex in poorly drained sites. Between 16 000 and 12 500 ^{14}C years rapid changes in the plant populations occurred, particularly involving species of willow, grass, sedge and herbs. By 12 500 the entire area was occupied by a mosaic of treeless communities in response to a slow amelioration of the climate. At 12 000 a rapid transition from a warming glacial to a non-glacial climate stimulated the spread of dwarf shrubs (ericads and birch), increased organic sedimentation, soil humification and paludification, and a gradual increase in spruce until the modern extent and structure of woodland complexes was reached at about 7500 B.P. Slight changes did occur later (6000 B.P.) as alder and tree birch expanded to their modern modest status in the vegetation.

The oldest radiocarbon age recorded for these lake sediments is 16 000 years, suggesting that, contrary to the original hypothesis, the extensions of Laurentide ice that occupied Doll Creek valley and adjacent areas were part of the latest glacial maximum (18 000 to 20 000 years B.P.).

3170 RITCHIE, J.C. (1984)

A Holocene pollen record of boreal forest history from the Travaillant Lake area, Lower Mackenzie River Basin; Can. J. Bot., Vol. 62, No. 7, pp. 1385-1392.

A 396 cm sediment sequence from SW Lake in the boreal woodland zone near Travaillant Lake, Northwest Territories, Canada, provides a Holocene record of pollen percentages and species interactions. Three local pollen assemblage zones are described: a Betula - Populus - Juniperus zone from 10 500 to 9000 years BP, a Picea - Betula zone from 9000 to 5100 years BP, and a Picea - Betula - Alnus zone from 5100 years BP to the present. The earliest vegetation recorded at this site is a mosaic of poplar groves, juniper and Shepherdia shrub, and fragmentary patches of tundra, replaced rapidly by spruce woodland at roughly 8500 years BP, dominated initially by Picea glauca. Picea mariana spread extensively between 8500 and 5000 years BP, probably as a function of increasing paludification. The present spruce-dominated vegetation was in place by 5000 years BP. Some changes in the pollen record can be explained by the Milankovitch early Holocene period of warmer summers followed by a cooling to modern conditions by 5000 years BP. Others require explanations in terms of edaphic factors of biological interactions among the main taxa.

3171 RITCHIE, J.C. (1985)

Late-Quaternary climatic and vegetational change in the Lower Mackenzie Basin, Northwest Canada; Ecology, Vol. 66, No. 2, pp. 612-621.

A 355-cm sediment sequence from Twin Tamarack Lake near Inuvik, Northwest Territories, Canada, provides a 14 500-yr record of pollen percentages and accumulation rates, interpretable in terms of climatic change and plant community dynamics. Four distinct pollen assemblage zones are recognized: a Gramineae-Artemisia-Cyperaceae-Salix zone from 14 500 to 11 800 BP; a Betula glandulosa zone from 11 800 to 8400 BP, subdivided into four subzones (Gramineae-herb, Populus, Salix, and Juniperus); a Picea-Betula zone, from 8400 to 5900 BP; and a Picea-Betula-Alnus zone from 5900 to 0 BP. The vegetation during the late-glacial at this site (14 500-11 800 BP) was relatively stable, consisting of sparse herb tundra on uplands in a slowly warming climate. Dwarf birch increased during this phase. The early Holocene period of maximum summer radiation produced thermal conditions ≃10% warmer than present, initiating a change from tundra to woodland at most sites, effected by the efficiently dispersed Populus (chiefly P. balsamifera). Relatively rapid changes in regional vegetation occurred during this period (11 800 to 6500 BP); Juniperus invaded the poplar woodlands, occupying well-drained, favorable sites, and later the slower-dispersed Picea (chiefly P. glauca) arrived and formed stands on alluvial sites, largely replacing poplar. At ≃7500 BP, Betula papyrifera spread on to the uplands; the accumulation of fuel, accelerated by the spread of conifer woodlands, likely caused in increase in fire frequency, which in turn maintained arboreal birch in the area. Fire opened up the woodlands locally and promoted the spread of Alnus crispa, expressed in the pollen record as a prominent rise in both percentage and PAR values. Picea mariana and other species adapted to mire habitats spread at this time (≃7000 BP) as paludification, peat growth, and permafrost aggradation occurred in the extensive lowlands. The termination of summers warmer than at present (≃6000 BP) initiated the development of a relatively stable vegetation that has persisted to the present.

3172 RITCHIE, J.C. (1987)

Comparaison entre la végétation du Mackenzie et du Nord Québécois à l'Holocène; Géographie physique et Quaternaire, Vol. XL1, N° 1, pp. 153-160.

Le Québec-Labrador et la région de la vallée inférieure du Mackenzie ont en commum quelques traits phytogéographiques, mais leur histoire végétale postglaciaire est largement différente. Les caractéristiques structurales et floristiques de la toundra arbustive, de la toundra forestière et de la taïga se ressemblent fortement. On trouve aussi des clones disjoints et isolés de Populus balsamifera dans les deux régions. Les bioclimats sont différents sous quelques rapports, notamment les précipitations annuelles, les caractéristiques de la couverture de neige, le régime annuel des températures et la saison de croissance. Toutefois, le déroulement et la chronologie de la déglaciation ont été les facteurs qui ont déterminé les différences les plus importantes entre les deux régions en ce qui a trait à l'histoire de la végétation. La region occidentale, libérée des glaces vers 15 000 BP, a été dominé par une toundra herbeuse pendant les deux millénaires qui ont suivi. Vers 13 000-12 000 BP, les toundras arbustives (Betula glandulosa, Ericales, Salix) se sont étendues puis les forêts de Populus, d'abord, et de Picea, ensuite, se sont succédé de 10 000 à 9000 BP. Au début de l'Holocène, la moyenne de rayonnement solaire estival a atteint son maximum et la limite septentrionale de la zone forestière s'est déplacée au nord. Par la suite, vers 6000-4000 BP, l'aulne (Alnus) s'est établi et la pessière a laissé place à une toundra arbustive, et ce, jusqu'à nos jours. Par contre, la partie centrale du Nouveau-Québec est demeurée englacée jusque vers 6500 BP et la colonisation initiale a été remplacée par les arbres (Picea, Larix) et les arbustes (Alnus). Les différences entre les deux régions s'expliquent par l'âge de la déglaciation, l'influence de la calotte résiduelle sur le climat, la proximité du stock floristique disponible et les voies de migration des plantes.

3173 RITCHIE, J.C., and CWYNAR, L.C. (1982)

The Late Quaternary vegetation of the North Yukon; in Paleoecology of Beringia, Chapter 6, Academic Press Inc., New York, pp. 113-126.

The arctic-steppe concept is tested by scrutiny of two detailed late Pleistocene herb-zone pollen records from Hanging Lake (tundra) and Lateral Pond (woodland) in northern Yukon Territory and by consideration of other published pollen sequences in eastern Beringia. In particular, we examine the idea that Alaska and northern Yukon, when joined to Siberia by the Bering land bridge, "constituted the eastern end of a huge grassland biome, unequaled today in size and character".

Herb-zone pollen spectra consist largely of taxa whose modern affinities are arctic-alpine. Contrary to expectations of the arctic-steppe concept, herb-zone spectra do not show diversity of pollen taxa higher than in the modern pollen rain. Pollen influx rates are as low or lower than during the Holocene at the same sites and an order of magnitude lower than in modern central Canadian prairies. Influx rates for Artemisia, as well as for most of the other prominent herbs and grasses, are about the same in the herb zone as in younger pond sediments, although herb-zone taxa form much smaller percentages of the total pollen rain after birch, alder, and spruce appear in younger sediments. Pleistocene pollen spectra from western Europe are interpreted as representing open, discontinuous tundra or polar desert severely affected by frost action. The eastern Beringian herb zone also probably records discontinuous tundra vegetation floristically and physiognomi-

cally similar to communities found in eastern Beringia today on xeric, regosolic sites above the montane or beyond the arctic treeline. The communities represented by the herb zones are not extinct but are restricted in distribution now due to competition by species adapted to the more leached and humic Holocene soils and species that have immigrated or expanded in response to climatic amelioration.

We conclude that the "arctic steppe biome" never existed in eastern Beringia during the late Quaternary. The large and diverse ungulate populations probably were present during Pleistocene interstadials more than 30,000 years ago - intervals for which we lack adequate palynological records - rather than during the time of the herb zone, 30,000 to 14,000 years ago. It is doubtful that herb-zone vegetation could support a large and diverse population. Termination of the herb zone by the dwarf birch "rise" about 14,000 years ago signals a climatic amelioration (warmer and wetter). It is unlikely that the spread of this more productive vegetation was a factor in late Pleistocene mammalian extinctions.

3174 RITCHIE, J.C., HADDEN, K.A., and GAJEWSKI, K. (1987)

Modern pollen spectra from lakes in arctic western Canada; Can. J. Bot., Vol. 65, No. 8, pp. 1605-1613.

Fifty-four samples of modern sediment from Banks Island and the Melville-Horton region of the Northwest Territories illustrate the major features of pollen deposition from the high to low arctic. Modern pollen deposition in the high arctic of Banks Island is characterized by up to 14% windblown tree pollen. Indicator taxa of the high and mid arctic include Oxyria (<5-23%). Saxifragaceae, Saxifraga oppositifolia, and Cruciferae (all up to 8%) and Dryas (up to 3%). Arboreal pollen increases to 60% in low-arctic and subarctic samples. Pollen concentration decreases from between 3 500 and 20 000 in the low arctic to less than 5 000 grains/cm^3 in the high and mid arctic. Pollen spectra from the Late Glacial of northwestern Canada differ from those of the modern high and mid arctic not only by the absence of trees and shrubs but also in the relative proportions of Artemisia and of such indicator taxa as Oxyria and Saxifragaceae.

3175 STEERE, W.C., and SCOTTER, G.W. (1986)

Bryophytes of the Cape Parry and Bathurst Inlet Region, Northwest Territories; Canadian Field Naturalist, Vol. 100, No. 4, pp. 496-501.

The Cape Parry and Bathurst Inlet regions, located in the central northern edge of the continental arctic portion of North America, are important in providing information on the distribution of the American arctic bryophytes, such as whether or not the ranges extend that far from the eastern Arctic or represent easterly ranges of the Beringian (western arctic) elements in the flora. The comparative inaccessibility of these regions has left their cryptogamic flora largely unstudied until now. The nearest bryophyte studies are those to the west at the Reindeer Preserve, to the south in the Great Bear Lake and Coppermine regions, and to the southeast in the Keewatin District. Scotter had the opportunity to collect bryophytes as part of a natural resource inventory from the Cape Parry region during 1978 and from the Bathurst Inlet region during 1979.

3176 SVOBODA, J. (1987)

Keewatin gardens and green igloos farm - a successful pilot project in Arctic horticulture; in Proc. Meeting on Northern Climate, Can. Climate Program, October 8-9, 1986, Yellowknife, N.W.T., pp. 94-98.

Attempts to grow vegetables and other crops in cold regions of Canada can be dated to days of the first northern posts and missions. These were, however, restricted to the belt south of the tree line. More recently in newly established settlements throughout Keewatin and Mackenzie regions, occasional hobby greenhouses were built, and usually shortly thereafter abandoned. Proposals to introduce more systematic methods and greater tenacity of purpose into the development of arctic agriculture did not find adequate government support in the past. Yet our five year studies at two arctic localities show clearly that at least small scale horticulture in tundra regions of Canada is biologically possible and economically feasible.

3177 SVOBODA, J., HUTCHISON-BENSON, E., and TAYLOR, N.W. (1986)

Arctic Cushion Plants as Fallout 'Monitors'; J. Environ. Radioactivity, Vol. 4, pp. 65-76.

The internal distribution of fallout ^{137}Cs was determined for arctic cushion plants Dyras intergrifolia, Silene acaulis and the bryophytes Rhacomitrium lanuginosum and Polytrichum juniperinum collected at various latitudes in the Canadian Arctic. The results indicate that these plants have functioned as biological monitors of radioactive fallout and it is suggested that analysis of the internal distribution of ^{137}Cs could serve as a model for other airborne contaminants.

3178 TIMONEY, K.P. (1988)

A geobotanical investigation of the subarctic forest-tundra of the Northwest Territories; unpub. Ph.D. thesis, Dept. Botany, Univ. Alberta, 292 p.

A geobotanical study of the high subarctic region west of Hudson Bay was undertaken to provide a verifiable and quantitative delimitation of the forest-tundra. Three field seasons of vegetation and landscape studies provided ground truth for a matrix of 1314 National Air Photo Library black

and white airphotos. The photos form a grid spanning the forest-tundra, with overlap into the low subarctic and low arctic, from the Yukon-Mackenzie border to the west coast of Hudson Bay.

Airphotos were analyzed for percent cover of nine vegetation-terrain types, occurrence of selected patterned ground features, bedrock and parent materials, landforms, and elevations. Vegetation contour maps and transect diagrams were computer-drawn from percent cover data; occurrence maps of patterned ground features were prepared.

Tree and upland tundra vegetation are discussed in relation to climate, topography, and landscape. The following conclusions were reached: (1) the forest-tundra spans an average 150 ± 75 km and on average increases in width from northwest to southeast; (2) the predominant pattern of spatial change in tree and upland tundra cover in the forest-tundra is approximated by a sigmoid curve. Gradual change in percent cover at both high and low cover values, and steep gradients in mid-range, are typical; (3) two distinct vegetation-climate-terrain regions are indicated: the Northwest (Mackenzie valley to Coppermine River) and the Southeast (Great Slave Lake to Hudson Bay). Between these regions, crossover of vegetation and climatic isolines occurs at a major landscape transition north of Great Slave Lake; (4) highlands account for most southern outliers of forest-tundra in the Northwest; (5) in the Northwest, steep gradients in tree and upland tundra cover usually occur near the northern limit of the forest-tundra; white spruce is the dominant tree. On the acidic terrain of the Southeast, steep vegetation gradients occur near the southern limit of the forest-tundra; black spruce is the dominant tree; (6) the Northwest is colder and receives only about 3/4 the mean annual net radiation available to the Central and Southeast forest-tundra. Edaphic restriction of trees on poor sandy Shield soils, and compensation on higher quality loams in the Northwest may help account for this vegetation-climate anomaly; (7) trees are generally restricted to wet and wet-mesic mineral soils at their northern limits. Conversely, the southern limit of upland tundra is typically found on dry, coarse-textured soils; (8) the areal pattern of burn in the subarctic is understandable in relation to fire weather, terrain influences, regeneration time, and the location of steep vegetation gradients.

Vegetation cover maps for the subarctic NWT may prove useful as baseline data to assess current and future changes in the plant cover. Overviews of plant communities and species groups, zonation criteria and synonymy, soil nutrient regimes, and indicators of soil pH, moisture, and climate, are presented.

CESAR

3179 ASUDEH, I., GREEN, A.G., and FORSYTH, D.A. (1988)

Canadian expedition to study the Alpha Ridge complex: results of the seismic refraction survey; Geophys. J., Vol. 92, pp. 283-301.

A crustal-scale seismic refraction survey has been conducted in the Arctic Ocean across the NE Alpha Ridge complex and its northern flank within the SE Makarov Basin. The data from the four reversed profiles have been analysed using 1-D and 2-D synthetic seismogram modelling schemes. Upper crustal velocities beneath these parts of the Alpha Ridge complex and Makarov Basin are surprisingly uniform at 5.0-5.2 km s^{-1}, increasing smoothly and rapidly to $\simeq$6.5 km s^{-1} at depths of only $\simeq$8 km. Below this level the velocities continue to increase relatively smoothly, reaching values of $\simeq$7.0 km s^{-1} at depths ranging from 14 to 19 km. Mantle-type velocities of $\geq$8.0 km s^{-1} are found at depths of 36-44 km beneath some regions of the Alpha Ridge complex and 21-25 km beneath the SE Makarov Basin. Based on these results and other geophysical and geological data from the Arctic Ocean we interpret the Alpha Ridge complex as an Icelandic-type structure generated by Mantle Plume activity, and we suggest that the region of Makarov Basin surveyed is underlain by a thick oceanic crustal section.

3180 FORSYTH, D.A., MOREL-À-L'HUISSIER, P., ASUDEH, I., and GREEN, A.G. (1986)

Alpha Ridge and Iceland-products of the same plume?; J. Geodynamics, Vol. 6, pp. 197-214. CESAR Contr. No. 30.

Refraction results from the 1983 Canadian Expedition to Study the Alpha Ridge suggest a crustal model with many similarities to the region of Iceland. The overall character of the seismic sections, the derived velocity structure, the lateral dimensions of crustal transition zones and the general crustal thicknesses are comparable from the Arctic and Atlantic regions. Additional similarities are noted in the alkalic basalts, the subaerial to subaqueous, within-plate volcanic environment and the positive regional magnetic responses at satellite altitudes.

Based on the geophysical semblances and the apparent evolutionary sequence of within-plate volcanism and tectonic events extending from the northern Ellesmere-Greenland area to Iceland, it is proposed that the Alpha Ridge and Iceland may have been affected by the same mantle plume.

3181 FORSYTH, D.A., ASUDEH, I., GREEN, A.G. and JACKSON, H.R. (1986)

Crustal structure of the northern Alpha Ridge beneath the Arctic Ocean; Nature, Vol. 322, No. 6077, pp. 349-352.

Beneath the Arctic Ocean, the Alpha Ridge complex is the principal tectonic feature between the Canada Basin and the Lomonosov Ridge. Here we report on analysis of seismic refraction data along the Alpha Ridge and within the basin area 175 km to the north, which, together with geological and aeromagnetic constraints, indicates that the Alpha Ridge is characterized by regions of continental-like thickness but has probably resulted from an oceanic mode of development. The ridge flank thins towards the North Pole but may extend as far north as 88°N, and is therefore >500 km wide in the region near 110°W. Consequently, south of the pole along 110°W, typical oceanic crust beneath the eastern Makarov Basin may be present only locally, if at all. Similarities between the velocity structures of the Alpha Ridge and the Iceland area suggest that the Icelandic structure may be a currently active analogue for the Alpha Ridge.

2990 JACKSON, H.R., MUDIE, P.J., and BLASCO, S.M. (1985)

Initial geological report on CESAR - the Canadian Expedition to study the Alpha Ridge, Arctic Ocean; Geol. Surv. Can., Paper No. 84-22, 177 p.

2991 JACKSON, H.R. (1985)

Knowledge of the Alpha Ridge prior to CESAR; in Geol. Surv. Canada Paper 84-22, pp. 11-14. CESAR Contr. No. 8.

3182 JACKSON, H.R., and JOHNSON, G.L. (1986)

Summary of Arctic geophysics; J. Geodynamics, Vol. 6, pp. 245-262.

The Cenozoic history of the Eurasian Basin is well understood because it involves the Eurasian (EU) and North American (NA) plates and is therefore constrained by data from more southerly regions and contains a readily decipherable magnetic pattern. Reconstruction of the older portion of the Arctic Ocean is more difficult; however, information collected on ice station CESAR in 1983, interpreted in conjunction with regional geologic and geophysical data, provides insight into its oceanic affinities and age. A dredged outcrop of the Alpha ridge, consisted of weathered fragmental alkaline volcanic rocks. Refraction data reveal a thick crust nearly 40 km and a high velocity lower crust on this ridge. The basal layer velocity is typical of all plateaus known to be oceanic crust. It is hypothezied that Alpha Ridge therefore represents a late Cretaceous oceanic plateau. A more recent analogue is the Iceland-Faeroe Ridge. The magnetic information are shown to be consistent with this interpretation of oceanic crust. The Amerasia Basin is closed by rotating the Arctic-Alaska plate against NA during the Cretaceous. This reconstruction, its timing and its position are consistent with the geology of the Canadian Arctic Islands and Alaska.

3183 MUDIE, P.J., STOFFYN-EGLI, P., and VAN WAGONER, N.A. (1986)

Geological constraints for tectonic models of the Alpha Ridge; J. Geodynamics, Vol. 6, pp. 215-236, CESAR Contr. No. 31.

Initial interpretations of the CESAR geological samples are re-examined in light of new data from the Alpha Ridge and circum-Arctic region. A composite stratigraphy for the CESAR and Fletcher Island (T-3) pre-Neogene cores shows a sequence of Campanian-Maastrichtian organic-rich terrigenous mud overlain by Maastrichtian-Eocene biosiliceous marine deposits with a low organic content, terminating in volcanoclastic mudstone of Late Eocene age. CESAR core 6 contains a transition zone in which biosiliceous sediment is replaced by volcanoclastic and terrigenous sediment of Paleocene-Eocene age. Palynomorphs provide a Late Eocene age for the volcanic outcrop dredged from Northern Alpha Ridge. Textural and geochemical studies of laminated biosiliceous sediments were made with special techniques for quantitative analyses of very small samples (1-10 mg) and particle sizes of less than 5 microns. Results show that the laminated sediments were deposited very slowly in an oxidizing environment. Laminae in CESAR core 6 mainly reflect cyclical variations in the formation and/or accumulation of particulate iron, probably due to periodic hydrothermal venting. Absence of detrital sediment, sparsity of pyroclastic material and lack of diagenetic alteration of the biogenic sediments suggest that the eastern Alpha Ridge was not an area of major tectonic activity during the Eurekan Orogeny, from ca. 80-40 Ma.

3184 NIBLETT, E.R., KURTZ, R.D., and MICHAUD, C. (1987)

Magnetotelluric measurements over the Alpha Ridge; Phys. Earth Planet Inter., Vol. 45, pp. 101-118.

Magnetic and telluric field variations were recorded on the Arctic Ocean sea ice over the Alpha Ridge in April and May, 1983. The magnetotelluric measurements were made near the base camp of Operation CESAR (Canadian Expedition to Study the Alpha Ridge) to investigate the deep structure and electrical properties of the lithosphere and upper mantle beneath the ridge. Thirty days of usable data were obtained within the period range 120-20 000 s. During the experiment the base station drifted across a deep (2000 m) median valley or graben lying parallel to the ridge axis and then over a steep rise on its northern flank. One data set was obtained over the graben and the

remainder of the measurements were made as the station travelled back and forth over the rise. The directional properties of both the geomagnetic induction arrows and the magnetotelluric impedance tensors were consistent with changes in water depth along the drift path. One-dimensional inversions of E-polarization MT data revealed a resistive lithosphere about 70-85 km thick with a conductive (10 Ωm) upper mantle (asthenosphere?) below. Sea-water depths estimated in the inversion process agreed remarkably well with the known bathymetry, indicating that the ocean floor contained less than 100 m of highly conducting sediments along most of the drift path. Two-dimensional models required simulation of the topography of the entire section of the Alpha Ridge between the Canada and Makarov Basins in order that a satisfactory fit be obtained to the H-polarization data. Two-dimensional forward modelling indicates that the anisotropic character of the impedance measurements can entirely be attributed to the bathymetry of the ridge. The data provided no indication of structural inhomogeneity within the oceanic crust and lithosphere, consistent with results from companion seismic refraction and gravity surveys.

The thickness of the lower conducting region was not resolved because reliable long period data (T >20 000 s) were not available for analysis. Impedance estimates at these periods were poorly determined and subject to rapidly rising tensor skew. They were also subject to bias errors caused by water movements, in particular the M_2 tide.

3091 PROUSE, N.J. (1984)

Biological sampling program: CESAR Expedition; Abstract in Can. Geophys. Union, 11th Annual Meeting, Dalhousie Univ., Halifax, N.S., May 29 - June 1, 1984, p. 102.

3092 PROUSE, N.J., and McALLISTER (1986)

The Glacial Eelpout, Lycodes frigidus, from the Arctic Canadian Basin, New to the Canadian Ichthyofauna; Can. Field Naturalist, Vol. 100, No. 3, pp. 325-329.

3185 SWEENEY, J.F., and WEBER, J.R. (1986)

Progress in understanding the age and origin of the Alpha Ridge, Arctic Ocean; J. Geodynamics, Vol. 6, pp. 237-244, CESAR Contr. No. 29.

Multiparameter geophysical measurements and geological samples from CESAR suggest that close to Canada the Alpha Ridge is oceanic in nature and was built in part by volcanic activity. It is unclear whether this part of the ridge formed in an intraplate or a plate margin environment. Estimates from paleontological, heat flow and magnetic data place the construction of a volcanic ridge within the Cretaceous period between about 120 and 80 Ma ago, the interval in which the Canada Basin seafloor formed but clearly before the creation of the Lomonosov Ridge. The place of the Makarov Basin in this chronology remains unclear.

3186 TAYLOR, A., JUDGE, A., and ALLEN, V. (1986)

Terrestrial heat flow from project CESAR, Alpha Ridge, Arctic Ocean; J. Geodynamics, Vol. 6, pp. 137-176. CESAR Contr. No. 32.

During two months in spring, 1983, a multidisciplinary study, project CESAR, was undertaken from the sea ice across the eastern Alpha Ridge, Arctic Ocean. In the geothermal program, 10 gradiometer profiles were obtained; 63 determinations of in situ sediment thermal conductivity were obtained with the same probe, and 714 measurements of conductivity using the needle probe method were obtained on nearby core.

Weighted means of the thermal conductivity of the sediment are 1.26 W/mK (in situ) and 1.34 W/mK (core), consistent with the compacted sediment encountered across the ridge and with the lithology. Calculated terrestrial heat flow values, corrected for the regional topography, range from 37 to 72mW m^{-2}; the average is 56+/- 8 m Wm^{-2}.

Some temperature and heat flow versus depth profiles exhibit non-linearities that can be explained by physically reasonable (but otherwise unsubstantiated) variations in bottom water temperatures preceding the measurements; models are hypothesised that reduce the curvatures. Two heat flow values considerably higher than others in the area may be explained by higher bottom water temperature over several years, while the low value is consistent with a recent deposition from a slump. This hypothetical modelling reduces the scatter of heat flows and reduces the average to 53 +/- 6m Wm^{-2}.

The CESAR heat flow is somewhat greater than expected for a purely continental fragment but is consistent with crust of oceanic origin. The heat flow is similar to values obtained in Cretaceous back-arc basins. Based on the oceanic heat flow-age relationship, the heat flow constrains the age of the ridge to 60-120 million years. The heat flow observed on other seismic features in the world's oceans suggests that the Alpha Ridge has experienced no significant tectono-thermal event in the last 100 million years.

3187 VAN WAGONER, N.A., WILLIAMSON, M-C., ROBINSON, P.T., and GIBSON, I.L. (1986)

First samples of acoustic basement recovered from the Alpha Ridge, Arctic Ocean: new constraints for the origin of the ridge; J. Geodynamics, Vol. 6, No. 1-4, pp. 177-196. CESAR Contr. No. 34.

The Alpha Ridge is one of three subparallel trending ridges that cut the Arctic Ocean. It is roughly Late Cretaceous to Eocene in age, and

seismic refraction records suggest it comprises a thick sequence of oceanic crust. During the 1983 CESAR expedition 20 similar samples of acoustic basement were dredged from the walls of a major graben of the Alpha Ridge, at one site. These are the only basement samples ever recovered from the ridge and provide the first direct evidence for its nature, composition and possible origin.

The basement samples are highly altered pyroclastic rocks, composed almost entirely of basaltic volcanic clasts with little matrix. Although the rocks are highly altered, most primary textures and structures are preserved. Most clasts are highly amygdaloidal to scoriaceous, fine grained to glassy, and angular to subround with rare vesicle controlled boundaries. Little reworking is suggested because a single clast type predominates, many of the clasts are subangular, and any amount of reworking would result in destruction of the delicate scoriaceous clasts.

Rare clinopyroxene phenocrysts comprise the only unaltered portion of the rocks. They are salitic in composition ($WO4_{9\ 53}$, $En_{32\ 41}$, $Fs_{11\ 15}$), with significant amounts of Ca, Al and Ti. Salitic clinopyroxenes are typical of alkalic basalts.

Interpretation of the whole rock geochemistry based on relatively immobile elements, (Nb, Zr, TiO_2 and Y), and chondrite-normalized incompatible trace element and REE patterns indicates that the volcanic rock fragments are of alkalic basalt. Geochemical discriminators suggest a within-plate tectonic setting.

Textual evidence suggests that the CESAR basement rocks were sampled from a rapidly emplaced submarine fallout deposit that was erupted at a depth at least less than 800 m and likely less than 200 m. High extrusive rates would have been required to build the ridge up to shallow depth prior to the cessation of volcanism. The alkalic affinity of the rocks strongly suggests that the Alpha ridge was not formed by volcanism at an island arc or a mature spreading centre. It is also unlikely that it formed as a "leaky" fracture zone. Alkalic basalts, however, are commonly associated with various types of oceanic aseismic ridges. It is suggested that the Alpha Ridge is an aseismic ridge that formed due to voluminous hotspot volcanism as spreading began in the Canada Basin. Such hotspot activity may have been responsible for initiating the rifting, breakup, and dispersal that eventually formed the Canada Basin.

2996 WEBER, J.R., and COOPER, R.V. (1988)

Crustal structure of the Alpha Ridge and Eastern Canada Basin; Abstract in, Joint GAC, MAC, CSPG Annual Meeting, May 23-25, 1988, Memorial Univ. of Newfoundland, St. John's, Nfld., Program of Abstracts, Vol. 13, p. A13.

2997 WEBER, J.R., and HALLIDAY, D.W. (1984)

Bathymetry and gravity of the Alpha Ridge; Abstract in Proc. Can. Geophys. Union, 11th Annual Meeting, Dalhousie Univ., Halifax, N.S., May 29 - June 1, 1984, pp. 83-84.

2998 WEBER, J.R., and JACKSON, H.R. (1985)

CESAR bathymetry; Geol. Surv. Canada, Paper 84-22, pp. 15-17. CESAR Contr. No. 9.

2999 WEBER, J.R. (1987)

Maps of the Arctic Basin Sea Floor Part II: Bathymetry and Gravity of the Alpha Ridge: The 1983 CESAR Expedition; Arctic, Vol. 40, No. 1, pp. 1-15. CESAR Contr. No. 20.

3188 WEBER, J.R. (1986)

The Alpha Ridge: gravity, seismic and magnetic evidence for a homogenous, mafic crust; in Polar Geophysics, eds. G.L. Johnson and K. Kaminuma, J. Geodynamics, Vol. 6, pp. 117-136. CESAR Contr. No. 33.

Gravity and bathymetric results from the 1983 Canadian Expedition to Study the Alpha Ridge (CESAR) have outlined positive free-air anomalies centred on the continental break off Ellesmere Island characteristic of normal Atlantic-type passive margins. These data confirm implications derived from depth-to-magnetic basement calculations that the ridge may not be structurally connected to the continent. Across the Alpha Ridge magnetic and gravity anomalies mimic the bathymetry. The magnetic anomalies apparently are not caused, to any great extent, by internal structures or magnetic reversals, but rather seem to result simply from variations in depths to a homogenous magnetic structure. The gravity anomalies across a 500 km wide section of the Alpha Ridge can be almost completely accounted for by topography, shallow sedimentary fill and a simple two-tier crustal model. This implies an extraordinary lateral density homogeneity unknown in continental structures of comparable size. Gravity models show the crustal thickness to increase gradually from 20 km at the Marvin Spur to 38 km at the ridge crest. A comparison of this model with a gravity model of the continental-type Lomonosov Ridge, which has a thickness of about 25 km, indicates that, at the same thickness of 25 km, the average crustal density of the Alpha Ridge is 0.08 Mg/m^3 greater. These gravity constraints, the unusually homogenous seismic velocity structure revealed by the CESAR studies, the homogeneous magnetic structure, and the extraordinary high intensity satellite magnetic anomaly associated with the Alpha Ridge, indicate that the ridge may be composed of a large pile of mafic rock, possibly unique on this planet.

CLIMATOLOGY

3189 ALT, B.T. (1985)

Atmospheric circulation in the Canadian High Arctic; Annals of Glaciology, Vol. 7, Proc. Sym. on Snow and Ice Chemistry and the Atmosphere, August 19-24, 1984; Trent Univ., Peterborough, p. 213.

The high Arctic pollen sites, studied by the Polar Continental Shelf Project, lie in the region dominated by the cold-core westerly circumpolar vortex which is a unique feature of high Arctic atmospheric circulation. The characteristic slow-moving, or quasi-stationary, cold lows of a non-frontal nature, which extend from the surface to the upper atmosphere, produce moisture and aerosol transport conditions which differ considerably from those to the south over southern Baffin Island and the mainland. The geographical position of the transition zone separating these two distinct circulation regimes is now under investigation but it appears to pass between Penny Ice Cap and Bylot Island under present-day summer conditions.

3190 ALT, B.T. (1987)

Atmospheric circulation in the Queen Elizabeth Islands; Abstract in Proc. XII INQUA Congress, Ottawa, Ontario, August 1987, p. 120.

Present mean climate patterns in the Queen Elizabeth Islands (QEI) are a result of the interaction of atmospheric circulation conditions with topography. A wide range of climate conditions are experienced across the islands with mean July temperatures near 1°C along the exposed Polar Ocean littoral and higher than 8°C at the same latitude in the sheltered valleys of north central Ellesmere Island.

The QEI presently lie in the region dominated by the cold core circumpolar vortex, a unique feature of high Arctic atmospheric circulation. Synoptic controls of climate and of moisture and aerosol transport for this region differ significantly from those for Baffin Island and mainland Canada.

Available analogs of circulation conditions at various times during the Quaternary show that the QEI lie in a transition zone between the central Polar Basin and continental North America and have been subject to a complex series of circulation events.

3191 ALT, B.T. (1987)

Regional climate studies in the Queen Elizabeth Islands; Abstract in Program and Abstracts, The Canadian Arctic Islands, Canada's Missing Dimension, An International Meeting Sponsored by the National Museum of Natural Sciences, November 21-24, 1987, Ottawa, Canada, p. 50.

The Queen Elizabeth Islands (QEI) lie in the region dominated by the cold-core circumpolar vortex, a unique feature of High Arctic atmospheric circulation. Synoptic controls of climate and of moisture and aerosol transport for this region differ significantly from those for Baffin Island and mainland Canada. Regional summer climate patterns over most of the QEI results from the interaction of major topographical features with persistent northwesterly flow off the cold Polar Ocean. A distinctive "S"-shape is seen in mean monthly sea-level plots of most summer climate parameters. July maps feature 1°C and 80% cloud cover along the exposed Polar Ocean littoral compared to 8°C temperatures and 60% cloud cover at the same latitude in the intermontane region of central Ellesmere Island. Synoptic analogues can be used to study the impact of interannual and long-term climate variations on the geosphere, and the biosphere, including people. Proxy climate records from the QEI show that the period since the beginning of instrumental climate record (1949-present) has been dominated by anomalously high summer temperatures compared to the last 700 years, but there is as yet no evidence of continued warming.

3192 ALT, B.T. (1987)

Developing Synoptic Analogs for Extreme Mass Balance Conditions on Queen Elizabeth Island Ice Caps; J. Climate and Applied Meteorology, Vol. 26. No. 12, pp. 1605-1623.

Detailed synoptic and climate analyses were undertaken for summer seasons during which extreme mass balance conditions were recorded on glaciers in the Queen Elizabeth Islands in high Arctic Canada. Three types of mass balance extremes were considered: (1) summer melt maxima; (2) suppression of summer melt; and (3) summer accumulation maxima. The following synoptic analogs were developed for these situations: (1) intrusion of a ridge into the Islands at all levels in the troposphere, and the consequent absence of the North American trough produces high melt and highly negative mass balance conditions; (2) maintenance of a deep cold trough across Ellesmere Island and down Baffin Bay with the resulting northwest flow off the Polar Ocean in the Queen Elizabeth Islands suppresses melt, and produces positive balance conditions on all Queen Elizabeth Island ice caps; and (3) tracking of surface and upper lows south and southeast across the islands from the Polar Ocean produces accumulation of snow in the summer and the most positive mass balance conditions in the record.

These analogs can be applied to paleoclimatic problems.

3193 ALT, B.T., KOERNER, R.M., FISHER, D.A., and BOURGEOIS, J.C. (1985)

Arctic climate during the Franklin Era, as deduced from ice cores; in The Franklin Era in Canadian Arctic history 1845-1859, ed. P.D. Sutherland, Nat. Museum of Man Mercury Series, Archaeological Survey of Canada Paper No. 131, pp. 69-92.

Ice cores from near the top of High Arctic ice caps provide a means of studying past climate. Time series of summer melt layers, oxygen isotope ratios and regional pollen concentrations from High Arctic ice caps are used to study climate conditions during the years of the Franklin expedition and subsequent search activities. The analysis shows that the Franklin Era (1845-1859) was the culmination of a 50-year period of consistently unfavourable summers. Based on modern synoptic analogs, the climate and sea ice conditions for the era can be summarized as: a) northwesterly flow off the Arctic Ocean penetrating the Canadian Arctic Islands and as far south as Keewatin; b) short, cold, cloudy summers with frequent poor visibility; c) a maximum of one year in five with open water in the Peel Sound-Franklin Strait-Victoria Strait area; d) frequent summers experiencing little or no breakup of sea ice along some portion of Franklin's route, in other words, conditions were considerably worse than modern normals and, in fact, the Franklin Era appears to have been one of the least favourable periods in the past 700 years. While the successful completions of the Northwest Passage made by Amundsen and Larsen were undertaken during more favourable periods than the Franklin attempt, only the icebreaker Labrador encountered conditions surpassing modern normals.

3194 BARRY, R.G., COURTIN, G.M., and LABINE, C. (1981)

Tundra climates: Climatic overview; in Tundra ecosystems: a comparative analysis, eds. L.C. Bliss, O.W. Heal and J.J. Moore, International Biological Programme No. 25, Cambridge Univ. Press, pp. 81-114.

An understanding of the climates of polar and alpine tundras has been greatly delayed by the paucity of observational data. The major synoptic and dynamic features of the arctic atmosphere were not established definitively until the 1950s and knowledge of the physical climatology of the tundra remains scant, especially in the case of alpine tundras. This chapter first surveys the general climatic setting of the tundra and in the light of this perspective the IBP site data are then examined.

3146 EDLUND, S.A. (1986)

Vegetation-geology-climate relationships of western Melville Island, District of Franklin, in Current Research, Part A, Geol. Surv. Can., Paper 86-1A, pp. 719-726.

3147 EDLUND, S.A. (1986)

Modern Arctic vegetation distribution and its congruence with summer climate patterns; in Proc. Climate Change Impacts in the Canadian Arctic; Canadian Climate Program Workshop, March 3-5, 1986, Orillia, Ontario, ed. H.M. French, Atmospheric Environment Service, Downsview, Ont., pp. 84-99.

3149 EDLUND, S.A. (1987)

Plants Livir) Weather Stations; GEOS, Vol. 16, No. 2, pp. 9-13.

3195 FISHER, D.A., and ALT, B.T. (1985)

A global oxygen isotope model - semi-empirical, zonally averaged; Annals of Glaciology, Vol. 7, Proc. Sym. on Snow and Ice Chemistry and the Atmosphere, August 19-24, 1984; Trent Univ., Peterborough, pp. 117-124.

A simple model, which is zonally averaged, for the transport of atmospheric water vapour is presented which uses as input the zonally averaged evaporation field and the mean meridional travel distance of tropospheric water vapour as functions of latitude. The model demonstrates that for polar regions each of the 10° latitude strips poleward of 25° is of equal importance as a moisture source. The model is used to predict zonal averages of $\delta(^{18}O)$ for the present day and 18 ka BP. Both annual average values and seasonal amplitudes are presented and compared to observations. Sea-ice cover is an important factor in determining both annual averages and seasonal amplitudes today and at 18 ka BP. An earlier model linking $\delta(^{18}O)$, the deuterium excess, and sea-salt content in an Antarctic ice core to the relative humidity of the source region is based on a single-source atmospheric water-vapour cycle type model and is re-evaluated using the present model.

3196 FISHER, D.A., REEH, N., and CLAUSEN, H.B. (1985)

Stratigraphic noise in time series derived from ice cores; Annals of Glaciology, Vol. 7, Proc. Sym. on Snow and Ice Chemistry and the Atmosphere, August 19-24, 1984; Trent Univ. Peterborough, pp. 76-83.

Because of snow drifting, two time series of any variable derived from two adjacent ice cores will differ considerably. The size and statistical nature of this noise element is discussed for two kinds of measured substance. A theory is developed and compared to data from Greenland and Canadian Arctic ice cores. In case 1, the measured substance can diffuse and the seasonal cycle degrade with time and depth, e.g. $\delta(^{18}O)$. In case 2, the measured substance cannot diffuse, e.g. microparticles. The case 2 time series contain

drift noise proportional to that in the accumulation series. For accumulation series, the spectral power is concentrated at the high frequencies, i.e. is "blue". Such noise can be easily reduced by taking relatively short time averages. The noise in the case 1 time series, however, starts out "blue" but quickly diffuses to have a "red" character with significant power at longer wavelengths, and many decades of such series must be averaged to reduce the noise level. Because the seasonal amplitude of any given variable is an important input to the drift noise and because the seasonal amplitudes of some variable types are latitude-dependent, some sites have inherently less drift noise than others.

3197 JEFFRIES, M.O., and KROUSE, H.R. (1984)

Arctic ice shelf growth, fiord oceanography and climate; Band, Vol. 20, Universitätsverlag Wagner, Innsbruck, pp. 147-153.

The salinity and $\delta^{18}O$ profiles of a 31.8 m ice core from the Ward Hunt Ice Shelf, and the $\delta^{18}O$ and tritium composition of Disraeli Fiord are described. Changes in fiord oceanography and arctic ice shelf growth during the past 4000 years are discussed. Major events include initial thick sea ice formation ca. 4200-4100 BP; ice shelf thickening during the period ca. 4200-4100 BP to ca. 3400-3000 BP; establishment of stratified conditions in the fiord ca. 3400-3000 BP or soon after; ice shelf thinning and freshwater flushing beneath the ice ca. 2500-2000 BP to ca. 1600 BP; further sea ice accretion post ca. 1600 BP.

3198 KOERNER, R., BOURGEOIS, J., and ALT, B. (1988)

Snow Freezes Moments in Time; GEOS, Vol. 17, No. 2, pp. 1-5.

Scientists study ice cores to find out about past climates.

3157 MacDONALD, G.M., and RITCHIE, J.C. (1986)

Modern pollen spectra from the western interior of Canada and the interpretation of Late Quaternary vegetation development; New Phytol., Vol. 103, pp. 245-268.

2971 McGHEE, R. (1980)

Archaeological evidence for climatic change during the last 5000 Years; in Climate and History: Studies in past climates and their impact on Man; eds. T.M.L. Wigley, M.J. Ingram and G. Farmer, Cambridge Univ. Press, Cambridge, pp. 162-179.

3163 NEARING, M. (1986)

Sylvia Edlund - fun in a cold climate; Youth Science News, Vol. 16, No. 1, p. 15.

3168 RITCHIE, J.C. (1979)

Towards a Late-Quaternary Palaeoecology of the Ice-Free Corridor; Can. J. Anthropology, Vol. 1, pp. 15-28.

3169 RITCHIE, J.C. (1982)

The modern and Late-Quaternary vegetation of the Doll Creek area, North Yukon, Canada; New Phytol., Vol. 90, pp. 563-603.

3171 RITCHIE, J.C. (1985)

Late-Quaternary climatic and vegetational change in the Lower Mackenzie Basin, Northwest Canada; Ecology, Vol. 66, No. 2, pp. 612-621.

3172 RITCHIE, J.C. (1987)

Comparaison entre la végétation du Mackenzie et du Nord Québécois à l'Holocène; Géographie physique et Quaternaire, Vol. XL1, N° 1, pp. 153-160.

3173 RITCHIE, J.C., and CWYNAR, L.C. (1982)

The Late Quaternary vegetation of the North Yukon; in Paleoecology of Beringia, Chapter 6, Academic Press Inc., New York, pp. 113-126.

3176 SVOBODA, J. (1987)

Keewatin gardens and green igloos farm - a successful pilot project in Arctic horticulture; in Proc. Meeting on Northern Climate, Can. Climate Program, October 8-9, 1986, Yellowknife, N.W.T., pp. 94-98.

EQUIPMENT

3199 COMPUTING DEVICES OF CANADA LTD. (1962)

Report covering the analysis of Polar Continental Shelf Project's Decca Navigator Lambda Chain 1961 Operations; Polar Cont.Shelf Proj., internal report, 54 p.

3200 HUNT, F.P. (1964)

Hudson Bay Oceanographic Project; Polar Cont. Shelf Proj., internal report, 3 p.

3201 PULKKINEN, H.W. (1973)

Hydrographic surveying with air cushion vehicles, Trials Report, Evaluation of modified retractable fixed strut echo sounder, December 10-19, 1971; Polar Cont. Shelf Proj., internal report, 27 p.

This report is a compilation and condensation of the technical reports written by persons taking part in trials of the Depth Sounding System designed for Hovercraft SRN-5 and SRN-6.

3202 QUEK, S.H. (1983)

Spline smoothing of two-dimensional data series with precision estimation applied to satellite navigation; Univ. New Brunswick, Dept. Surveying Engineering, Tech. Rep. No. 101, 271 p. LOREX Contr. No. 19.

Noisy two-dimensional data series are a common occurrence in the geodetic field. As a result of this, numerous algorithms have been formulated to separate the systematic components from the noise within the observed data series. These algorithms, however, are not applicable to all types of data series. In this thesis, the performance of the piecewise cubic function, as a means of smoothing such data series, is investigated.

Cubic splines have, in the past, been used as smoothing algorithms. However, they proved ineffective in dealing with two-dimensional data series as they were developed with a weighting scheme for only one of the two variables. Hence they cannot accept a fully populated covariance matrix associated with each observed data point. The spline algorithm developed in this thesis uses both parameterized cubic splines and the method of least-squares to formulate a weighting scheme which allows the incorporation of the two-dimensional covariance matrices of the observations.

The resulting spline approximation technique is then used to smooth the navigation data sets of the three ice camps of the Lomonosov Ridge Experiment (LOREX) in the vicinity of the North Pole in 1979. The Navy Navigation Satellite System (Transit) was used as the primary positioning system. Error models evaluating the accuracy of the position fixes using Transit satellites at high latitudes are developed. Smoothed positions and velocities for the three ice camps at one-hour intervals are computed for the duration of the expedition.

To evaluate the performance of the spline algorithm the smoothed data series produced by the spline algorithm (DSPLIN) and the real-time smoothing technique (SMOBS) used during LOREX are compared with those generated by the precise dynamic package (GEODOP), i.e. DSPLIN versus GEODOP and SMOBS versus GEODOP. The smoothed data series produced by the precise dynamic technique (GEODOP) are hence used as a reference standard. In the comparisons between the smoothed data series of positions and velocities for the three ice camps, a reduction of about 56 and 47 percent in the root mean square of the differences in position and velocity respectively, is achieved by DSPLIN over SMOBS. In the same comparisons, the maximum discrepancy between individual smoothed positions is reduced by about one-half (i.e. from 3758 m to 1564 m). The computed standardized position differences between the smoothed positions produced by the spline algorithm and the precise dynamic technique shows that the precision estimates computed by the spline algorithm are consistent with accuracy only over certain periods of time in the LOREX data spans.

3203 WOODS, M.V. (1986)

Horizontal Accuracy of Soundings and the ARGO DM-54; Lighthouse, Edition No. 33, pp. 5-9.

All soundings gathered during the 1985 survey off Kugmallit Bay in the Beaufort Sea were positioned with the ARGOS-DM54 Medium Frequency (1702 kHz) positioning system. The ARGO chain was calibrated on board the C.S.S. John P. Tully with the Super High Frequency (Microwave 9500 MHz) Del Norte Trisponder 542 positioning system. Two ARGO receivers on board, one operating in the Range-Range mode and one in the hyperbolic mode, were used to continuously monitor the ARGO chain throughout the duration of the survey. The launches operated in the hyperbolic mode, with all sounding positioned by three hyperbolae. The horizontal accuracy of these soundings depends on chain configuration (geometry) and proper calibration techniques.

GENERAL

3204 ADAMS, P. (1984)

The McGill Axel Heiberg Station with an inventory as of June 1983; McGill Univ., internal report, 36 p.

3205 ADAMS, P. (1986)

Research station on Axel Heiberg Island, Northwest Territories, Canada; Polar Record, Vol. 22, No. 139, pp. 431-433.

In 1959, after examination of the new air photographs, the late Dr. F. Müller led a small party to various locations on Axel Heiberg Island to select an area which would be appropriate to become a long-term base for high arctic research. The area around what is now known as Expedition

fiord, on the west side of the island, was selected. In 1960 two houses were built near the head of the fiord, beside Colour Lake. These formed the base for a number of major expeditions in the 1960s and for many field parties led by Dr. Müller and others up to the present day.

3206 ADAMS, W.P. (1988)

Bases for Field Research in Arctic and Subarctic Canada; Arctic, Vol. 41, No. 1, pp. 64-70.

There are more than 50 field stations in northern Canada. These are operated by governments, universities and private agencies. Although many have a particular disciplinary bias, such as marine science, meteorology, native studies, archaeology, limnology, glaciology or biology, most are available to all researchers as a base of operations. Approximately half of the stations are in the Northwest Territories, the remainder in the Yukon and northern parts of the provinces. A table is provided indicating seasonal availability, particular research emphases, level of services provided, accommodation available and ownership. There is no user charge at some stations; most levy a daily fee. The highest cost in 1987 was just over $200 (food and accommodation) per day for the station on the Ice Island, then located northwest of Axel Heiberg. The paper also contains mention of 25 circumpolar stations outside Canada and a bibliography.

3207 ANONYMOUS (1982)

Transglobe Souvenir; London Sunday OBSERVER, August 1982, 16 p.

3208 BUTLER, R.S. (1985)

The Northwest Passage Propagation Experiment: Report of the 1983-1984 Measurement Program; Communications Canada, CRC Report No. 1391, 42 p.

An experiment was undertaken in 1982 to study radio propagation conditions in the VHF and UHF bands in the Canadian Arctic Islands near latitude 75°N. There were five UHF paths having both ends elevated to study point-to-point relay links. At VHF there were nine paths from near sea level to sites at various elevations to study links from ship to shore. Path lengths were in the range 60 to 100 km and were representative of the paths needed to a maritime mobile communication system to cover the entire Northwest Passage.

This report covers the measurements made between September 1983, and January 1985. Annual, seasonal, and worst-month statistics are presented and analyzed. It is concluded that reliable VHF communications can be provided to ships in the Northwest Passage using modest transmitter powers (less than 3 watts per 25 kHz voice channel), while very low transmitter powers (less than 0.1 watts per channel) would be adequate for UHF relay links between VHF sites.

3020 COMPUHEAT SERVICES CANADA INC. (1986)

Infra-red detection and acoustic deterrent study Cape Churchill, Manitoba, 1984; Report to Govt. of the N.W.T., Renewable Resources, Yellowknife, File Report No. 55, 49 p.

2989 DICKINS, D., MARTIN, L., BJERKELUND, I., POTTER, S., ERICKSON, D., HARPER, J., NORTON, P., JOHNSON, S., and VONK, P. (1987)

Environmental Atlas for Beaufort Sea Oil Spill Response; Env. Can., Environmental Protection Service, Yellowknife and Whitehorse, 235 p.

3209 DICKINSON, R.J.S., CROAL, J.P., and EATON, R.M. (1964)

Hovercraft in hydrographic survey; P.C.S.P. internal report, 27 p

Report on a visit to Britain to assess the Westland SR.N5 as a hydrographic survey craft.

3210 FRENCH, H.M. (1983)

Terrain and environmental problems associated with exploratory drilling, northern Canada, in Proc. 4th Inter. Permafrost Conf., Final Proceedings, Nat. Academy Press, Washington, D.C. pp. 129-132.

There appears to be no easy solution to the terrain and environmental problems of oil exploration in northern Canada. However, the continued application of the Territorial Land Use Act and Regulations, together with the positive attitudes increasingly adopted by the operators themselves, are leading to fewer problems that cannot either be resolved or minimized. In the boreal forest-shrub tundra environments of northern Yukon, terrain disturbances associated with well drilling in recent years have been minimized. Where there is a lack of ice-rich surficial deposits, the relative rapidity of natural revegetation is important in reducing terrain damage. In spite of this, terrain disturbance and sump-related problems do still occur in other localities in northern Canada, especially north of treeline in the ecologically more delicate tundra and polar, semi-desert environments. They emphasize the desirability of site-specific solutions to minimize impact and a thorough understanding of permafrost-vegetation relationships, in addition to the imposition of general land use operating conditions.

3211 FRENCH, H.M. (1985)

Surface Disposal of Waste Drilling Fluids, Ellef Ringnes Island, N.W.T.: Short-term Observations; Arctic, Vol. 38, No. 4, pp. 292-302.

An experimental procedure by which waste drilling fluids were placed upon the tundra was undertaken at the Panarctic Dome et al. Hoodoo N-52 wellsite on Ellef Ringnes Island during the early winter of 1981-82. Preliminary site investigations indicated ice-rich permafrost conditions and the potential for extensive terrain disturbance if a sump were constructed. During the summer of 1982 seepage of waste effluent away from the disposal area occurred, and a quantity of muds and supernatant waters entered an adjacent creek. Water-quality analyses indicated that leaching of heavy metals was slow in the short term and soluble components were quickly diluted to background levels. The major toxicity threat posed by drilling wastes is primarily one of high salinity. The low level of terrain disturbance associated with a sumpless operation is a major advantage of such a procedure.

3212 GREGOR, D.J. (1987)

Evidence of atmospheric transport and deposition of toxic substances in Canadian Arctic snow: 1986 Progress Report; Env. Canada, Water Quality Branch, 60 p.

The rather lengthy introduction above is intended to provide the background for the study of the snow chemistry of the Arctic initiated in 1986. There is irrefutable evidence of the presence of anthropogenic contaminants within the biological system of the Arctic and work has been initiated to assess the potential effect of these contaminants upon natives dependent upon these biota as a major component of their diet. The pathway or pathways of these contaminants; however, in the Arctic ecosystem remains in question. Background contamination of the oceans has been suggested as one possible source. The deposition of contaminants to the Arctic snow pack from the atmosphere has been substantiated; however, the magnitude of this pathway is unknown.

3213 HEGINBOTTOM, J.A., and SINCLAIR, M.P. (1985)

Cumulative Index to Permafrost Conference Proceedings (1958-1983); Geol. Surv. Can., Open File Report 1135, 215 p.

This index covers the published proceedings volumes and field excursion guidebooks produced for four international Conferences on Permafrost (1963, 1973, 1978 and 1983), four Canadian Permafrost Conferences (1962, 1964, 1969 and 1981) and eight smaller meetings on special aspects of permafrost science and engineering held in Canada between 1971 and 1979. The main subject index is a computer generated, key-word index of titles; separate regional and author indexes are included. Of the nearly 1200 papers, etc., indexed, all but 35 are in English or have been translated into English. Of these 35, one is in French and 34 are in Russian; English abstracts are available for all of these.

3214 HOBSON, G.D., and VOYCE, J. (1983)

Titles and Abstracts of Scientific Papers Supported by PCSP; Polar Cont. Shelf Proj., Dept. Energy, Mines & Resources, Cat. No. M78-5/5-1983E, 92 p.

3215 HOBSON, G.D., and VOYCE, J. (1985)

Titles and Abstracts of Scientific Papers Supported by PCSP; Polar Cont. Shelf Proj., Dept. Energy, Mines & Resources, Cat. No. M78-5/6-1985E, 79 p.

3216 HOBSON, G.D., and VOYCE, J. (1987)

Titles and Abstracts of Scientific Papers Supported by PCSP; Polar Cont. Shelf Proj., Dept. Energy, Mines & Resources, Cat. No. M78-5/7-1987E, 100 p.

3217 HOBSON, G.D. (1986)

Logistics Support for Arctic Scientific Camps and Drifting Ice Stations; in Proc. Inter. Polar Transportation Conf., May 4-8, 1986, Vancouver, B.C., IPTC Air Logistics Support, Vol. 2, pp. 462-472.

Scientific exploration in the High Arctic requires constant, safe, experienced and superior logistical support in all aspects. There is a very slim margin for error - a small error may be forgiven but a major mistake can be serious. Only aircraft types and experienced pilots that have proven themselves in cold regions should be trusted to move people and equipment in such a harsh environment. Long-term contracts allow for long-term planning for both charterer and carrier.

Equipment supplied to scientists and technicians must be cold-weather reliable and simple to maintain and operate. We must remember that the closest replacements may be hundreds or, in some cases, thousands of miles distant. Radio communications are essential - every camp must talk with home base preferably twice a day - to report local weather and the safety of the party. "if we do not hear from you we come looking for you".

Drifting ice stations on the Arctic Ocean present peculiar problems as opposed to land or inter-island camps. The establishment of a camp on an ice floe requires considerable experience to pick a reliable site and then it may become an impossible task to hold the station together during July to October when there is considerable movement in

the pack ice. An ice island station is easier to establish but has its peculiar summer problems also.

3218 LEHN, W.H. (1985)

A simple parabolic model for the optics of the atmospheric surface layer; Applied Mathematical Modelling, Vol. 9, pp. 447-453.

A simple yet accurate model is developed for optical ray tracing in the surface layer of a refracting atmosphere. The model consists of a small number of concentric spherical layers or shells, the surface of each being isothermal. If the temperature is taken to vary linearly between the surfaces, then the curvature of nearly-horizontal rays is approximately constant within each layer. Replacement of circular by parabolic arcs produces simple quadratic expressions for the rays. The procedure is easily implemented on a minicomputer, and a compact version fits into a programmable pocket calculator. This is particularly convenient for checking field observations. An example is given, as well as a discussion on error sensitivity due to simplifying assumptions.

3219 LEHN, W.H. (1986)

Anomalous Sunrises in Polar Regions; Polar Record, Vol. 23, No. 144, pp. 205-207

During the perpetual night of the arctic winter, the sun occasionally makes an unexpected reappearance. This phenomenon, called the Novaya Zemlya effect, is a specific type of anomalous atmospheric refraction that occurs in polar regions as a result of large-scale temperature inversions. The same effect is also responsible for the premature appearance of the midnight sun. A complete sequence of the midnight sun type of effect was photographed and documented for the first time on 16 May 1979.

3220 LEHN, W.H. (1986)

A Three-Parameter Inferior Mirage Model for Optical Sensing of Surface Layer Temperature Profiles; IEEE Transactions on Geoscience and Remote Sensing, Vol. GE-24, No. 6, pp. 940-946.

Inferior mirages provide a sensitive and fairly accurate probe for determining vertical temperature distributions in the atmospheric surface layer. Optical measurements on the image can be used to calculate the parameters in a temperature profile model, in this case a function with three adjustable parameters. The function contains an exponential term (two parameters) and an additive linear term (one parameter). The optical observations, for which a known target is required, consist of the elevation angles of the apparent peak, caustic, and horizon. Analytic expressions that must be simultaneously satisfied are derived for all three conditions. The parameter values are extracted numerically by minimizing a positive definite function of the three conditions. The model is tested on a set of images for which nearly simultaneous photographs, theodolite readings, and temperature profiles were available. For each image the three calculated elevations matched the measured values very closely. The complete images also match well in most of the cases. The results, a distinct improvement over previous two-parameter models, also provide a more accurate reconstruction than is obtained from the thermodynamic model for unstable stratification.

3221 LEHN, W.H. (1986)

Terrestrial Images transmitted by the Novaya Zemlya Effect; OSA Topical Meeting on Meteorological Optics, Honolulu, Apr. 3-4, Technical Digest, pp. 33-35.

Superior mirages are seen when the temperature of a stably stratified atmosphere increases with elevation. A classification into three types has been suggested: (1) strong nonuniform refraction over short ranges (hafgerdingar); (2) mild uniform refraction over medium ranges, giving the earth a flat or saucer-shaped appearance (hillingar); and (3) long range optical ducting beneath a thermocline (The Novaya Zemlya effect).

3222 LEHN, W.H., and MORRISH, J.S. (1985)

An inferior mirage model for the optical sensing of surface layer temperature profiles; International Geoscience and Remote Sensing Sym., Amherst, Mass., Oct. 7-9, Digest, Vol. 1, p. 363.

Inferior mirages provide a sensitive and fairly accurate probe for determining vertical temperature distributions in the atmospheric surface layer. In this work a three-parameter model is developed, which is a distinct improvement over previous models for the temperature profile. The criterion to be used in evaluating different models is the comparison of calculated images with actual observations.

3223 LEHN, W.H., and WALLACE, R.E. (1986)

Continous-Tone Mirage Images computed from Digitised Source Photographs, OSA Topical Meeting on Meteorological Optics, Honolulu, Apr. 3-4, Technical Digest, pp. 36-37.

The properties of mirage images corresponding to a given atmospheric model can be graphically summarised in two distinct ways: the image space, and the transfer characteristic. The former shows the apparent heights of surfaces of constant elevation, and is useful for estimating images of objects that possess considerable longitudinal extent, i.e. varying distance from the observer. The transfer characteristic is more convenient for objects concentrated near a single plane at a fixed distance from the observer. Detailed image

construction, however, is laborious with both representations; typically, the points on a line drawing of the object are individually mapped into new apparent positions and joined by straight lines to create a line drawing of the image. Entry of object data is slow; either individual x,y coordinates are entered by hand, or the object can be traced on a digitising tablet. Because the computed image is still only a line drawing, it is not entirely satisfactory. Certainly is not convincingly realistic when compared with a direct photograph of a mirage.

The process to be described here overcomes these shortcomings, and produces a realistic image based on the transfer characteristic approach. The two primary input quantities are (i) an atmospheric model, and (ii) an undistorted ('normal') photograph of the object. Secondary input parameters include observer elevation, object distance, and object height.

3224 LOCAT, J., KURFURST, P., BERUBE, M-A., CHAGNON, J-Y., and GELINAS, P. (1988)

Viscosimetric properties of a Beaufort Sea sediment; Geol. Surv. Can., Open File 1708, 13 p.

The Geological Survey of Canada has been involved for many years in the mapping of the engineering properties of soils in the Northwest Territories where large areas are underlain by frozen or unfrozen fine-grained sediments. In the case of frozen soils with high ice content or in the case of soft offshore sediments, it could be crucial to be able to calculate or predict the remolded strength or dynamic viscosity of the soil. This is especially true for the case of debris flows, for which run out distances must be predicted. In many cases, the remolded strength can be easily measured by means of the Swedish fall cone. However, this technique is not applicable for materials with liquidity indices higher than 3. Locat and Demers (1987) have extended the correlation between the liquidity index and the remolded strength to liquidity indicies higher than 3 by the use of a viscosimeter. They have proposed various correlations between yield stress, viscosity, remolded strength and liquidity index for sensitive clays of Eastern Canada. This paper reports on laboratory investigations carried out on a sample from the Beaufort Sea in order to validate this methodological approach for Beaufort Sea sediments.

3225 MacINNIS, J.B. (1985)

The Breadalbane Project: Implications for the discovery of Franklin's Ships; in The Franklin Era in Canadian Arctic history, 1845-1859, ed. P.D. Sutherland, Nat. Museum of Man Mercury Series, Archaeological Survey of Canada, Paper No. 131, pp. 174-184.

The Breadalbane Project was the first systematic search and survey of a high Arctic shipwreck. Organized through a non-profit foundation and carried out with government and corporate support, its primary objective was the continued development of a Canadian capability to operate beneath ice-covered waters. Its secondary objective was to locate and investigate the remains of the British three-masted barque, Breadalbane, lost in the Northwest Passage in 1853. After a total of eight search days spread out over three years, the Breadalbane was discovered in 1980, using side-scan sonar, two kilometers south of Beechey Island in 100 meters of water. In September of 1981, a series of unmanned dives was made using a remotely operated vehicle from the deck of a Canadian Coast Guard icebreaker. Eight hours of video tape and 800 still photographs were obtained. In the spring of 1983 a camp was constructed on the sea-ice over the ship, and 10 unmanned and four manned dives were made. Ten hours of video tape and 2000 still photographs were obtained. Several artifacts, including the ship's wheel, were recovered.

The project provided much-needed technical information about future search and salvage operations, which will be made for scientific, commercial and military purposes, in the high Arctic. The experience gained during the Breadalbane Project has direct implications for the search for Franklin's ships.

3226 MacINNIS, J. (1987)

Sailing the Northwest Passage by wind and muscle alone; Can. Geographic, Vol. 107, No. 3, pp. 26-33.

2974 McGHEE, R. (1985)

The Ancient Arctic; in The Arctic World, eds. F. Bruemmer and W.E. Taylor Jr., Key Porter Books, Toronto, Canada, pp. 201-208.

3227 MUNGALL, C. (1986)

Beaufort Sea Atlas; GEOS, EM&R, Vol. 15, No. 2, pp. 10-11.

Designed for resource developers, scientists and the general public, the atlas will provide information for planning safe engineering projects.

3228 PAGÉ, P., OUELLET, M., HILLAIRE-MARCEL, C., and DICKMAN, M. (1984)

Isotopic analyses (^{18}O, ^{13}C, ^{14}C) of two meromictic lakes in the Canadian Arctic Archipelago; Limnol. Oceanogr., Vol. 29, No. 3, pp. 564-573.

Meromictic Lakes Garrow and Sophia in the Canadian Arctic Archipelago were sampled to establish the origin and age of their waters by isotopic studies. The $\delta_{smow}{}^{18}O$ values reflect the permanent stratification of the waters in both lakes. The mixolimnia contain waters with an isotopic signal between -13.16 and -21.98‰, coherent with the values for precipitation in these high

latitudes. The short residence time of the water in this layer makes it possible to record episodic variations of the freshwater inputs to the lakes. In the chemoclines, the $\delta^{18}O$ values increase to -10°/oo concomitantly with a rise in chloride content to 42 g.liter^{-1}. This corresponds to a conservative mixing of surficial and deep waters. In the monimolimnia, hypersaline waters (up 2.5 times the salinity of seawater) show negative $\delta^{18}O$ values (ca. -8°/oo. These waters result from brine production during permafrost growth in the watershed, according to a Rayleigh process. The brines drained toward the deepest part of each lake, after postglacial uplift, and became isolated. ^{14}C dating of total inorganic carbon in the Lake Garrow monimolimnion gave an age of 2,580 ± 260 years B.P. In Lake Sophia, the deep waters exhibit recent ^{14}C activity (121.4% modern carbon) that suggests recent infiltration of seawater into the lake basin.

3229 PAGÉ, P., MICHAUD, J., OUELLET, M., and DICKMAN, M. (1987)

Isotopic composition and origin of lacustrine brines in the Arctic; Can. J. Earth Sci., Vol. 24, pp. 210-216.

Meromictic lakes in the Arctic Archipelago were analyzed to determine whether the isotope content of the water molecule might confirm their oceanic origin. The 25 m bottom layer of Lake Garrow, on Little Cornwallis Island, is filled with a homogeneous sodium chloride solution with 2.6 times the chloride concentration of seawater (52 g L^{-1}). Its $\delta 18_O$ value is around -10°/oo with respect to V-SMOW, and its δ^2H is eight times the oxygen value. In Lake Sophia on Cornwallis Island, the deep stratum (25 m thick) is less concentrated (35 ppt of Cl^{-1}) and shows slightly higher $\delta 18_O$ and δ^2H values (-9°/oo and -75°/oo respectively). Chemocline and surficial waters result from mixing between bottom waters and meteoric waters. The chemical and isotopic signals are interpreted as evidence of diagenesis through subpermafrost or intrapermafrost freezing of aquifers once filled with seawater, at some time during postglacial emergence.

3230 SHIMIZU, O. (1985)

Topographical change caused by thermal erosion of a massive ground ice body in Tuktoyaktuk, N.W.T., Canada; in Characteristics of the Massive Ground Ice Body in the Western Canadian Arctic Related to Paleoclimatology 1984-1985, ed. K. Fujino, Inst. Low Temp. Science, Hokkaido Univ., Japan, pp. 71-85.

In permafrost areas spreading in and around the Arctic regions, distinctive ground features such as ice-wedge polygons, pingos and involuted hills are commonly observed. These formations have been caused by frost action and are one of the most important topographical changes occurring in the permafrost areas. However, the topographical changes caused by thermocarst are also very important. Because the thermocarst brings about the changes more rapidly and more briskly than the frost action. French has pointed out that several types of thermocarst cause the most rapid topographical changes in erosion working around the western Arctic, Canada.

3112 STEWART, D.B., and BERNIER, L.M.J. (1984)

An aquatic resource survey of Melville Peninsula, Southampton Island, and the northeastern District of Keewatin, Northwest Territories; Env. Can. & Ind. & Northern Affairs Can., Land Use Infor. Series Background Rep. No. 4, 144 p.

3125 THOMAS, V.G., and MacDONALD, S.D. (1987)

The Significance of Terrestrial and Marine Oases in the High Arctic; in Proc. Sym. on Arctic Heritage, eds. J.G. Nelson, R. Needham, and Linda Norton, Aug. 24-28, 1985, Banff, Alta., pp. 147-153.

3231 WASHBURN, A.L., and WELLER, G. (1986)

Arctic Research in the National Interest; Science, Vol. 233, pp. 633-639.

The Arctic Research and Policy Act of 1984 was designed to advance arctic research in the national interest. Some of the research fields that require attention are weather and climate; national defense; renewable and nonrenewable resources; transportation; communications and space-disturbance effects; environmental protection; health, culture, and socioeconomics; and international cooperation. A research framework recommended by the Arctic Research Commission includes, in order of priority, integrated investigations to understand: (i) the Arctic Ocean (including the marginal seas, sea ice, and seabed) and how the ocean and atmosphere operate as coupled components of the arctic system; (ii) the coupled atmosphere and land components and how their interaction governs the terrestrial environment; and (iii) the high-latitude upper atmosphere and its extension into the magnetosphere with emphasis on predicting and mitigating effects on communications and defense systems. A separate recommendation is for high priority research to resolve the major health, behavioral, and cultural problems related to the arctic environment. Recommendations are also made concerning support services and management.

GEOLOGY

3232 ANDREWS, J.T. (1985)

Detrital carbonate accumulation on the shelf and in the fiords, Baffin Island, Eastern

Canadian Arctic; Abstract in 14th Arctic Workshop, Arctic Land-sea interaction, Nov. 6-8, 1985, Dartmouth, N.S., p. 58.

For at least two decades workers have commented on the significance of the detrital carbonate content of sediments from the deep sea shelf and fiord sediments of western Baffin Bay. A series of ten piston cores from shelf and fiord environments have been studied for their calcite and dolomite content using gasometric analysis of the 74um fraction, and XRD of both the clay- and silt-sized fractions. In most areas we have studied carbonates representing far-travelled, exotic minerals, that have been introduced into the glacial marine/marine setting through ice-berg rafting or suspended in melt-water plumes. Resuspension can also occur through a number of different processes. Carbonate contents range between c60% and a trace. Highest values occur in cores in and around outer Frobisher Bay and peak percentages occur during deglacial events. In the fiords there is a small but significant influx of detrital carbonate into the outer fiords starting in the last 4 ka which may reflect increased iceberg rafting from NW Greenland and/or increased resuspension of carbonate-rich shelf sediments. Calculations of the rate of carbonate accumulation ($mg/cm^2/yr$) give values that range between 375 and 0.5. During the last 5000 years or so carbonate accumulation has been affected by dissolution associated, in time, with the development of the cold Canadian Current.

3233 ASPREY, K.W., and SYVITSKI, J.P.M. (1985)

Transfer of magnetite from land to sea in Baffin Island fjords; Abstract in 14th Arctic Workshop, Arctic Land-sea interaction, Nov. 6-8, 1985, Dartmouth, N.S., p. 213-216.

Determination of the distribution of a single mineral can be a powerful technique to discern sediment sources and transport pathways in closed depositional systems. In 1983, samples were collected from fluvial-deltaic, beach and fjord (water column, prodelta and basin) environments. Magnetite was chosen as a tracer/indicator mineral because it is ubiquitous to the glacially eroded sediments of Baffin Island and is easily separated from mixtures of other primary minerals. Magnetite is also a heavy mineral (density of 5.18 $g\ cm^{-3}$) and is useful in discerning the placer potential of a particular depositional environment. The magnetic properties of sediment in arctic cores have been determined to provide a temporal component to modern sediment heavy mineral distributions.

Magnetic sediment traps were installed at depths of 15 and 35 m in Cambridge and Itirbilung fjords close to the fjord-head in about 50 m of water. In both cases the flux of magnetite was greatest at depth (1.1 to 2.3 x 10^{-3} g day^{-1} for the deeper traps compared to 6.7 to 9.2 x 10^{-4} g day^{-1} for the 15 m traps). The flux values are for fall season conditions in 1983 and are expected to be much higher during the spring freshet period. An earlier 1985 field season installation will confirm this hypothesis.

3133 BASINGER, J.F. (1987)

Fossil Flora of the Eocene Buchanan Lake Formation, Axel Heiberg Island, Canadian Arctic; Abstract In Program of Abstracts, GAC-MAC Joint Annual Meeting, Univ. Saskatchewan, May 25-27, 1987, Vol. 12, p. 23.

3234 BEAUCHAMP, B., OLDERSHAW, A.E., and KROUSE, H.R. (1987)

Upper Carboniferous to Upper Permian ^{13}C-enriched primary carbonates in the Sverdrup Basin, Canadian Arctic: comparisons to coeval western North American ocean margins; Chemical Geology (Isotope Geoscience Section), Vol. 65, pp. 391-413.

Carbon isotopes analyses performed on more than 250 limestone samples from thirteen late Paleozoic autochthonous formations of western and Arctic Canada demonstrate that: (1) for a given locality, the $\delta^{13}C$-values are uniform and there is no temporal increase in $\delta^{13}C$ during the whole Late Carboniferous (Pennsylvanian), Early Permian and basal Late Permian (latest Permian strata being absent); (2) there is a well-defined latitudinal trend showing that for any specific time interval, extremely high $\delta^{13}C$-values are encountered in the Sverdrup Basin (+5 to +7‰), intermediate but still high values in northern Yukon Territory (+3 to 5‰), and low values in east-central and southeastern British Columbia (+1 to +3‰).

A model is proposed whereby oceanic stagnation and thermohaline stratification prevailed in the Sverdrup Basin. As a result, large amounts of ^{12}C-enriched organic matter were preserved in central parts of the basin. As the organic matter accumulated, residual dissolved carbonate species became enriched in ^{13}C. Additional enrichment was also promoted by the escape of CO_2 from evaporating brines following intermittent closures of the Sverdrup Basin early during the Late Carboniferous.

Since the Sverdrup sea was connected to the Paleopacific ocean during most of its history, it acted as a source of ^{13}C-enriched surface waters which were then spread southward by wind-driven surficial currents. With this model, the trend of decreasing $\delta^{13}C$ in a southerly direction is explained by increasing dilution with waters of the Paleopacific along the western margin of North America.

3235 BENNETT, L.P., and FRENCH, H.M. (1988)

Observations on near-surface creep in permafrost, eastern Melville Island, Arctic Canada; in Proc. Fifth International Conf. on Permafrost, August 2-5, 1988, Trondheim, Norway, pp. 683-688.

Rates of near-surface frozen soil creep of between 0.03-0.05 cm/yr are typical of four sites on a low angle (5°) west-facing slope near Rea Point, Melville Island. Highest movements are concentrated in a 0.5 m thick ice-rich zone lying immediately below the active layer. At depths greater than 1.2 m, where ground temperatures rarely rise above -3.0°C, no measureable deformation was noted. These rates are of the same order of magnitude, although approximately two-thirds less, than those reported from relatively warm permafrost in the Mackenzie Valley. Variability of movement between sites may be related to differences in snow cover and resulting ground thermal conditions. An upslope movement component observed in winter is probably related to thermal contraction.

3236 BISCHOFF, L., and OSKIERSKI, W., (1985)

First results of a multidisciplinary analysis of the Haughton Impact Crater, Devon Island, Canada. II Structural Geology; Abstract in, Proc. XVI Lunar and Planetary Science Sym., Houston, Texas, pp. 65-66.

Previous investigations gave an insight into structural relationships and multi-ring character of the Haughton crater. However, little was known about the internal geological structure, the type and intensity of fracturing and folding, and of movements which took place during the modification state of the crater-forming event. Therefore, the lithologies, their lithostratigraphic correlations, strike and dip of bedding planes, faults and breccia dikes, degree of brecciation, fold axes and fold morphologies were studied in 4 segments of the crater, in the inner ring, and in the central basin. The preliminary results of our studies will be substantiated by statistical treatment of the data.

3237 BISCHOFF, L., and OSKIERSKI, W. (1988)

The Surface Structure of the Haughton Impact Crater, Devon Island, Canada; Meteoritics, Vol. 23, No. 3, pp. 209-220.

Recent geological and structural investigations support the existing descriptions of the Haughton structure being a dome-like structure. The central area represents the central uplift and is formed by blocks of rocks belonging to the oldest part of the Devon Island Paleozoic sediment cover. The orientation of the blocks partly reflects this dome-like structure. The morphologically defined "inner ring" is a structurally distinct zone, predominated by gypsum beds of the Bay Fiord Formation. These beds dip 30 to 40° outward and are asymmetrically folded. The outer radius of this ring is 5 to 5.5 km. A 1 to 1.5 km broad zone follows outward of more chaotically oriented blocks of rocks, which may be considered a megablock-zone. The next ring-like zone is strongly faulted ("faulted annulus") and obviously represents the downfaulted, once uplifted crater rim. Within this structural annulus, a marked asymmetry of the crater structure is expressed by the attitude of the faulted blocks. The structure of the northern and eastern segments of the faulted annulus differ substantially from those of the southern and western segments. This asymmetry may reflect heterogeneities in the pre-crater geology of a low angle impact. No evidence was found in support of the theory that the Haughton structure represents a multiring structure.

3238 BISSON, J.G., BURNS, R.A., DALLIMORE, S.R., GAGNÉ, R.M., GOOD, R.L., HUNTER, J.A., JUDGE, A.S., LAFLECHE, P., PULLAN, S.E., BURN, C.R., HARRISON, W.D., HORACK, J.L., NEAVE, K.G., and MacAULAY, H.A. (1988)

Geotechnical investigations off northern Richards Island, N.W.T. - 1987; Geol. Surv. Can., Open File 1707, 147 p.

The program components included: (1) Geology and geological engineering: drilling, sampling, core logging, core temperature measurements, cone penetrometer tests, cone penetrometer temperature measurements, surficial mapping and frost heave tests; and (2) Geophysics: uphold seismic measurements, temperature measurements, standard borehole logging (resistivity, natural gamma and SP), borehole heating test, seismic refraction measurements and ground probing radar surveys.

The details of the program field data are described and preliminary results are discussed in the following chapters.

3239 BLAKE, W., Jr. (1985)

Radiocarbon dating with accelerator mass spectrometry: results from Ellesmere Island, District of Franklin; in Current Research, Part B, Geol. Surv. Can., Paper 85-1B, pp. 423-429.

Radiocarbon dating by means of accelerator mass spectometry (AMS) has two great advantages over conventional dating: (1) much smaller samples can be handled; and (2) counting time is significantly shorter. Three examples are given for Holocene-age material from east-central Ellesmere Island. The results demonstrate the potential use of this technique as a powerful research tool in studies of Quaternary chronology. Individual fragments of marine shells as small as 0.1 g have been dated successfully at the IsoTrace Laboratory, University of Toronto. In the case of an aquatic moss from a lake sediment core, an increment 0.5 cm thick could be used instead of a 5 cm-thick slice, thus allowing a much more precise estimate of the onset of organic sedimentation.

3240 BLAKE, W. Jr. (1986)

New AMS radiocarbon age determinations from east-central Ellesmere Island; applications

to glacial geology; in Current Research, Part B, Geol. Surv. Can., Paper 86-1B, pp. 239-244.

Radiocarbon dating by means of accelerator mass spectometry has two great advantages over conventional dating: (1) much smaller samples can be handled; and (2) counting time is significantly shorter. Three new age determinations, all on marine mollusc shells of Holocene age from Ellesmere Island, are reported here. In one case the data confirms an earlier AMS result in showing that the front of MacMillan Glacier was well behind its present position 7800 to 7100 radiocarbon years ago. The other two AMS dates reinforce a conventional radiocarbon date and show that the earliest Holocene marine incursion in the Smith Sound-Kane Basin coastal region occurred approximately 9000 radiocarbon years BP.

3241 **BRAND, U. (1987)**

Geochemical analysis of Lower Paleozoic platform and reef carbonates of Somerset, Griffith and Cornwallis islands, Arctic Canada; Abstract in CSPG Canadian Reef Research Sym., Program of Abstracts, January 27-30, 1987, Banff, Alta., p. 20.

An Ordovician-Silurian sequence of carbonates and shales were examined on Somerset, Griffith and Cornwallis Islands. On Somerset the units consist of the Irene Bay, Allen Bay, Cape Storm, Douro and Somerset Island Formations. South of the facies boundary on Cornwallis Island, the following were examined: Irene Bay, Allen Bay, Cape Storm and the Douro, Barlow Inlet and Sophia Lake Formations of the Read Bay Group. North of the facies boundary, the calcareous shales/argillaceous limestones of the Cape Phillips Formation were collected for geochemical analysis.

Geochemically the Irene Bay Formation is similar on both Somerset (120 ppm Sr) and Cornwallis Islands (130 ppm Sr). Sodium values are low suggesting deposition of the sediments under normal to hypersaline marine conditions. Similarly, the Sr (60 ppm) and Na (200 ppm) values of the Allen Bay show little variation between the two islands, supporting the hypothesis of deposition under normal marine conditions. Subsequently, the formation was dolomitized by Dorag waters with a seawater dominance. Chemistry of the supratidal dolomites of the Cape Storm Formation changes from Sr lows (130 ppm) and Na highs (320 ppm) on Somerset to Sr highs (320 ppm) and Na lows (140 ppm) on Cornwallis Island. These trends suggest a deepening of the waters toward Cornwallis during deposition/formation of the Cape Storm sediments. Sediments of the Cape Phillips Formation have chemical contents similar to those of the Allen Bay and Cape Storm of Cornwallis supporting the increasing water depth hypothesis.

Strontium levels of the Douro Formation increase from 510 ppm on Somerset to 1460 ppm on Cornwallis. Similar high Sr levels are also noted in the Barlow Inlet and Member C of the Cape Phillips Formation. Chemical Levels in the Somerset Island and Sophia Lake Formation are down to normal values (320-430 ppm Sr). The dolomitized reef facies of the Barlow Inlet Formation are low in Sr (40-120 ppm) and high in Na (310-400), whereas the platform equivalents have high Sr levels with 1110 ppm. Mineralogical and diagenetic controls are advocated to be responsible for these drastic geochemical variations observed in the different facies of the formation.

3242 **BROWN, M.P. (1985)**

Glaciolacustrine Sedimentation in South Piper Pass, Northern Ellesmere Island; unpub. M.Sc. thesis, Dept. Geography, Univ. Alberta, 123 p.

The United States Range in northeast Ellesmere Island is dissected by a tectonic trench called Piper Pass, which contains three ice-dammed lakes. Abandoned lake sediments on the Hazen Plateau south of Piper Press, and raised shorelines within the Pass, indicate that more extensive lakes occupied this area in the past.

The research was principally concerned with the stratigraphy and sedimentology of these former lake basins. Related objectives included: (1) Surveying the well defined uppermost shoreline above South Lake (within Piper Pass) to determine whether this shoreline was isostatically tilted and whether it was related to the lacustrine sediments on the Hazen Plateau. (2) Examining the Hazen Plateau sediments and comparing them with a prominent ice-contact delta constructed into South Lake, in order to establish the relationship between sediment deposition and past ice margins within the Plateau Lake basin. (3) Collecting organic remains within these various lacustrine sediments for ^{14}C dating, to determine whether these lakes are either of postglacial or full glacial age.

The three ice-dammed lakes display shorelines up to 30 m above present lake levels. Organics collected from the 30 m shoreline above South Lake were dated at 1585 ± 190 BP, whereas deposits related to a lake level ≥16 m dated 495 ± 170 BP. Collectively these ^{14}C dates indicate that the changes in lake level occurred in the late Holocene. Aerial photographs taken in 1958 indicate that the lake was 13 m higher than the 1984 elevation. In addition, the absence of observable isostatic tilting along the uppermost shoreline reflects its late Holocene age. The recently expanded South Lake did not extend onto the adjacent Hazen Plateau. Furthermore, there is no evidence of higher lake levels to suggest that South Lake has ever extended out of Piper Pass. Therefore the higher sediments on the Hazen Plateau are not related to a lake within Piper Pass.

Two lacustrine deposits, reaching elevations of 145 m and 156 m above South Lake, mark a lake basin (Plateau Lake) which formerly occupied the northern edge of the Hazen Plateau. Plateau Lake

developed when the northward drainage into Piper Pass was blocked by the Turnabout Glacier debouching from the United States Range. At its maximum, Plateau Lake was 4 km long and 100 m deep. Powerful meltwater streams entered the east end of Plateau Lake from the nearby Divide Glacier and constructed a delta more than 1 km long. Gravels and sands were deposited in proximal parts whereas gently dipping silty-sand foresets prograded across silt-clay bottomset rhythmites in more distal areas. At the west end of Plateau Lake, fine sands, silts and clays were deposited as planar laminations by low velocity currents. Plateau Lake drained in several stages, finally leading to the erosion of sediments deposited at the former ice dam.

Four maximum ^{14}C dates (>33,000 BP, 15,040 ± 625 BP, 20,950 ± 1200 BP and 19,055 ± 2930 BP) obtained on terrestrial organics collected from the two lacustrine deposits indicate that Plateau Lake could be of full glacial age (>8,000 BP). The ^{14}C dates on these organics suggest that Plateau Lake existed for at least 5,000 years. This is supported by the stratigraphy and sedimentology of the lake deposits, which are used to reconstruct the area's paleogeography.

3243 BUCKLEY, D.E., and FITZGERALD, R.A. (1985)

Geochemical indicators of depositional environment in Baffin island Fiords; Abstract in 14th Arctic Workshop, Arctic Land-sea interaction, Nov. 6-8, 1985, Dartmouth, N.S., p. 59.

Sediment core samples from several fiords in eastern Baffin Island have been analyzed for a number of geochemical parameters, including total metals (Si, Al, Ca, Mg, Fe, Mn, Zn, Cu, and Ni) and potentially reactive metals, as determined by selective leaching methods. These data have been compared with other indicators of sedimentary geochemical conditions, including sediment pH, redox potential, total sulphide, total carbon, organic carbon, and water content.

The geochemical characteristics of these sediments are determined predominantly by the textural properties, which reflect the ratio of layered silicates to other detrital minerals derived from nearby provenances. Within a single fiord system, several sub-basins can be geochemically identified, with most of the depositional environments being classified as geochemically immature. This is indicated by low proportions of potentially reactive transition metals and this characteristic may be related to rapid deposition and burial.

Linear regression statistical tests are applied to geochemical data in order to test models of progressive diagenesis or maturity of the sediments along transects from the head of the fiords to the seaward extremities. These tests, generally, confirm that there is little systematic alteration within each fiord.

3244 CAMERON, A.R., NORRIS, D.K., and PRATT, K.C. (1986)

Rank and other compositional data on coals and carbonaceous shale of the Kayak Formation, northern Yukon Territory; in current Research, Part B, Geol. Surv. Can., Paper 86-1B, pp. 665-670.

The Mississippian Kayak Formation was examined and sampled systematically at five locations in northern Yukon Territory in order to assess the number, thickness, rank, petrographic characteristics, ash and sulphur content of exposed seams in relation to their tectonic setting in the Cordilleran orogenic system.

All of the seams examined are anthracites, suggesting thermal upgrading through a combination of deep burial and differential exposure to higher temperatures from igneous intrusions. All have a relatively high content of inertinite. One of the seams, with a measured thickness of about 5.5 m, has an ash content of under 7 per cent and an average sulphur content of about 0.5 per cent, and thus is a prospective source of good quality thermal coal. The high rank of the Kayak coals, however, suggests that the Mississippian and older rocks are not good oil prospects, although some parts of the Yukon Coastal Plain may be within the gas window.

3245 CAMERON, B.I., and MUECKE, G.K. (1988)

Petrochemistry and origin of permian basalts, Esayoo Formation, Sverdrup Basin, Arctic Canada; Abstract in Proc. GAC, MAC, CSPG Joint Annual meeting, May 23-25, 1988, St. John's, Newfoundland, Program with Abstracts, Vol. 13, p. A17.

Basaltic magmatism accompanied late Paleozoic rifting during the formation of the NE-trending Sverdrup Basin, Canadian Arctic Islands. The volcanic successions consist mainly of subaerial basaltic flows in the Late Carboniferous Auchild and the Permian Esayoo formations exposed on NW Ellesmere and northern Axel Heiberg islands. North of Greely Fiord, Ellesmere, the Esayoo attains a maximum thickness of 300 m, but rapidly thins to the west, where pillow lavas, epiclastic basalt conglomerates, and associated marine sediments indicate proximity to an ancient shoreline. Pyroclastics and interflow sediments are generally thin or absent from the succession.

Due to low-grade burial metamorphism, the original mineralogy has been converted to albite+chlorite+sphene+alkali feldspar+/-relict clinopyroxene+opaques. Elemental mobility investigations demonstrate that only high-field-strength elements and the light rare earths remained essentially immobile. $\delta^{18}O$ on whole rocks (9.5-14.5 °/oo), relict clinopyroxenes, and alteration phases indicate substantial basalt-formation water

interaction and/or crustal contamination. Unusually high barium values in some basalts (up to 2700 ppm) are hosted by interstitial alkali feldspars (up to 4 wt. % BaO) and may be attributed to formation waters that contacted underlying Carboniferous evaporites.

Discriminant diagrams involving immobile trace elements and the composition of primary clinopyroxenes reveal within-plate, alkaline affinities for the Esayoo metabasalts. REE patterns show enrichment in the LREE (La/Yb_n ~13) typical of alkaline basalts and, together with other trace elements, point to an origin by small degrees of melting of a garnet-bearing mantle source region.

3246 CAMPBELL, F.H.A. (1985)

Stratigraphy of the upper part of the Rae Group, Johansen Bay area, northern Coronation Gulf area, District of Franklin; in Current Research, Part A, Geol. Surv. Can., Paper 85-1A, pp. 693-696.

The Hadrynian Rae Group of the Johansen Bay area consists of a succession of buff-cream and white trough and planar crossbedded quartzites and quartz sandstones, which conformably overlie shallow water, locally stromatolitic, dolomite. The dolomite is ubiquitously intruded by diabase sills and dykes of varying thickness, whereas the overlying quartzite is cut only by rare dykes.

The quartzite is unconformably overlain by either terrigeneous clastics of Cambrian(?) age or basal quartzose carbonates of Ordovician-Silurian age. The unconformity surface on top of the quartzite is marked by a series of locally steep-sided or broad paleovalleys with relief locally up to 10 m vertically and up to 50 m over a distance of 0.5 km. The Cambrian(?) clastics, which occur only locally in the paleovalleys, are unconformably overlain by Ordovician-Silurian carbonates. This relationship suggests that there was a post-Cambrian(?) period of uplift and erosion prior to deposition of the overlying carbonates.

3247 CECILE, M.P. (1988)

Continuity of Paleozoic geology between northern Alaska and the Canadian Cordillera-implications for origin of Canada Basin; Abstract in, Proc. GAC, MAC, CSPG Joint Annual Meeting, May 23-25, 1988, St. John's, Newfoundland, Program of Abstracts, Vol. 13, p. A18.

One of the key elements in our understanding of the Canada Basin is the relationship between the ancestral northern Alaskan Arctic Plate (AAP) and the northwestern part of the ancestral North American Plate (NAP) during the Paleozoic. The obvious tectonic elements which now separate the AAP and NAP are the Kaltag Yukon and Richardson Eskimo Lakes fault systems. When examined critically neither fault system had a "major" component of strike slip and/or thrust displacement involving Paleozoic strata. The complex shallow water, carbonate-dominated Lower and Middle Paleozoic North American Miogeocline persists across both fault systems to the western end of the Brooks Range, Alaska. In the northern Canadian Cordillera the miogeocline was underlain by attenuated continental crust, thus it is very likely that continental crust was continuous between the AAP and NAP during the Paleozoic. Recent studies have also shown that the zone of enigmatic late Paleozoic orogenes is found in the Brooks Range and northernmost Yukon, and clastic facies associated with this deformation, persists across both fault systems. Furthermore the Paleozoic Richardson Trough was the failed arm of a triple rift system with the successful rifts lying to the north. Paleozoic strata east and west of the trough shale-out in a northerly direction indicating that the continental margin formed by the successful rifts had an orientation similar to the present day Beaufort Sea continental margins. Recent deep reflection seismic data show the presence of a substantial Proterozoic and/or Paleozoic continental margin beneath the eastern Mackenzie Delta area. All of this data suggest that very little movement of the AAP is required to restore Paleozoic rocks to their pre-Canada Basin configuration.

3248 CECILE, M.P. (1988)

Corridor traverse through Barn Mountains, northernmost Yukon; in Current Research, Part D, Geol. Surv. Can., Paper 88-1D, pp. 99-103.

The Barn Uplift is a small, ovoid, structural culmination of probable Laramide age that exposes a succession of highly deformed Cambrian to Devonian strata. These rocks are unconformably overlain by moderate to gently dipping Lower Carboniferous conglomerates of the Kekiktuk Formation. Three major stratigraphic units are recognized in the pre-Kekiktuk succession: Cambrian argillite, Orodovician chert, and Silurian shale. The Cambrian unit can be subdivided on the basis of colour, and contains a mappable limestone member. The Ordovician unit contains a mappable limestone member near its base in the western half of the area. The core of the uplift (pre-Kekiktuk Formation) can be divided into two structural domains: a western succession of steeply dipping imbricate thrusts, with strata in a single thrust panel younging westward; and an eastern zone of tight, upright folds. On the east side of the uplift is a thrust fault that places Cambrian argillite against an upper Paleozoic and/or Mesozoic succession of shale, siltstone and conglomerate. Small outcrops of Ordovician chert more than one kilometre east of this thrust are thought to be klippen.

3249 CHANDLER, F.W. (1988)

Geology of the Late Precambrian Fury and Hecla Group, Northwest Baffin Island, District of Franklin; Geol. Surv. Can., Bull. 370, 30 p.

The gently inclined, unmetamorphosed, miogeoclinal, Fury and Hecla Group consists of 6000 m of quartz arenite and minor shale and dolomite. Mafic volcanics and intrusives give Neohelikian to Hadrynian K-Ar whole-rock ages. The group is correlated with the lower part of the Bylot Supergroup, 200 km north. As with the Bylot, mainly shallow marine deposition is indicated with ocean to the west or northwest. The alluvial, basal, 500 m thick, Nyeboe Formation consists mainly of red quartz arenite. Marine dolomite pinches out eastward. The Sikosak Formation, at least 150 m of white quartz, contains 0-30 m of basalt flows of the Hansen Formation, which, descending westward in the Sikisak, suggest that the tidal marine unit migrated west. The Agu Bay Formation contains a 0-10 m basal stromatolitic shallow-water dolomite member, a 75 m marine shelf black shale member, both absent in the east, and a 500 m thick upward-coarsening and shoaling redbed member. Pinkish white quartzite of the shallow marine Whyte Inlet Formation thins west from 3 km to bare mappability. The Autridge Formation, with a lower Mikkelsen Member, 1500 m of drab quartz arenite and black shale, and an upper Cape Appel Member, 500 m of black shale, may be an outer shelf equivalent of the Whyte Inlet.

Uranium occurs in the subjacent granitic basement and in a quartz stockwork occupying a fault in the Nyeboe Formation.

3250 CHRISTIE, R.L. (1986)

The Melville Project, 1984-85: progress report; in Current Research, Part A, Geol. Surv. Can., Paper 86-1A, pp. 795-799.

A second field of the two-year Melville Project, a field and laboratory study of Melville Island, has been completed. The project comprises a broad spectrum of research, and several reports are in preparation. A review of Melville Island geology in the light of accumulated information allows some new interpretations for potential hydrocarbon-bearing reservoirs.

3144 CHRISTIE, R.L. (1988)

Field studies at 'fossil forest' sites in the Arctic Islands; in Current Research, Part D, Geol. Surv. Can., Paper 88-1D, pp. 57-60.

3251 DALLIMORE, S.R., and DAVIS, J.L. (1987)

Ground probing radar investigations of massive ground ice and near surface geology in continuous permafrost; in Current Research, Part A, Geol. Surv. Can., Paper 87-1A, pp. 913-918.

Field soundings using two new ground probing radar systems have been undertaken to map ground ice bodies and near surface geology at four sites on Richards Island, Northwest Territories and one site near Tuktoyaktuk, Northwest Territories. Preliminary correlation with borehole data indicates that the two radar systems are capable of mapping near surface soils to a depth of 10 m and in many areas to a depth of 30 m. At several locations where resistive materials such as ice or gravel occurred near the surface, reflections to 60 m depth were detected. Strong radar reflections were observed at the contacts between sediment and massive ice bodies even when the electromagnetic velocities of the sediment and the ice were similar.

3252 DE FREITAS, T. (1987)

Sponges from the Canadian Arctic; Abstract in, Can. Paleontology and Biostratigraphy Seminar, Geol. Assoc. of Canada, Sept. 25-27, 1987, London, Ontario, Program with Abstracts, p. 3.

The Cape Phillips shales of the Canadian Arctic have yielded perhaps the most diverse suite of Silurian fossil sponges known anywhere. Sponge assemblages represent small but discrete opportunistic communities that, during the Silurian, nucleated on thin turbidite beds at the basin-platform transition. Living in the stressful slope environment relatively free from competition with more effective space occupiers of the shallow water, the sponges proliferated to form thin biostromes. The communities were dominated by sponges (approximately 90 percent) with lesser amounts of algae, brachiopods, bryozoans, and crinoids. Sponges are of silica and well preserved, and are predominantly of one family, the Anthaspidellidae Miller: orchocladinid lithistids with a very-distinctive ladder-like skeletal construction. Also in the collection is the first reported Silurian sphinctozoan sponge, Rigbyspongia catenula de Freitas. This sponge, in contrast to the lithistids, was constructed of aspicular calcium carbonate, but was subsequently replaced by silica. Other representatives include small acorn-sized subspherical sponges belonging to two different lithistid suborders: Tricranocladina Reid and Sphaerocladina Schrammen. Isolated hexactine spicules are ubiquitous, but only a few complete specimens, constructed of weakley fused hexactines and belonging to the class Hexactinellida Schmidt, are represented. A systematic study of the collection has shown that at least thirteen new species and five new genera are present.

3253 DE FREITAS, T. (1987)

A Silurian sphinotozoan sponge from east-central Cornwallis Island, Canadian Arctic; Can. J. Earth Sci., Vol. 24, pp. 840-844.

The first Silurian sphinctozoan ever recorded is reported from the Canadian Arctic. The polysiphonate sphinctozoan, Rygoyspongia catenula n. gen., n. sp., is found associated with numerous anthaspidellid sponges. Diagnostic features of the new genus are its numerous axial siphons and vertical pillars within each chamber. Although it is structurally complex for a sphinctozoan of this age and is the only Silurian representative of the order, this new genus provides few clues to the still enigmatic problem of Paleozoic sphinctozoan phylogeny.

3254 DEUTSCH, A., TEUFEL, S., and METZIER-FERLING, A. (1985)

Isotope systematics in crystalline clasts of shock stage I - III from the polymict breccia of the Haughton Crater, Canada, Abstract in, Proc. XVI Lunar and Planetary Science Sym., Houston, Texas, pp. 239-240.

The Haughton Dome impact structure is located in a stratified target consisting of a 1700 m pile of paleozoic sediments on top of crystalline basement which is part of the Churchill province with metamorphic ages around 1.7 AE. Basement rocks found in the center of the structure or as clasts within the polymict breccia are shocked with pressures up to 60 GPa. The large time difference between the last regional metamorphism and the impact event (22 m.y.; and the nearly total absence of late hydrothermal reactions make crystalline rocks from Haughton very suitable for evaluating effects of shock metamorphism on isotope systems suitable for dating purposes.

3255 DEVANEY, J.R., and FYLES, J.G. (1988)

Sedimentology and stratigraphy of the Beaufort Formation, Prince Patrick Island, N.W.T.; Abstract in, Proc. GAC, MAC, CSPG Joint Annual Meeting, May 23-25, 1988, St. John's, Newfoundland, Program with Abstracts, Vol. 13, p. A31.

The Beaufort Formation (Neogene) exposed on Prince Patrick Island in the western Canadian Arctic islands is an unlithified and undeformed deposit consisting of the following facies: (1) clast-supported gravel (channel floor lags, longitudinal bars; (2) abundant cross-bedded sand (channel floor dunes, linguloid bars); (3) rippled sand; (4) plane-laminated sand (minor); (5) horizontally bedded fines--mixes of sand, mud, and woody detritus; (6) clay-rich mud (overbank suspension deposits); and (7) woody plant detritus, beds of flat-lying logs, sticks, twigs, wood chips, bark, leaves, moss, seeds, rare cones, insects (overbank deposits). Paleobotanical investigations indicate closed boreal forest and forest-tundra conditions.

The facies are interpreted to be sandy braided river deposits. Facies 1 to 4 represent bar and channel deposits, with facies 2 the most abundant. Facies 3 to 7, relatively minor in amount, are interpreted as low-stage overbank deposits. Rapid lateral facies changes are the norm. Well-defined fining upward sequences 1.2 to 2.5 m thick are uncommon.

Exposures along the long axis of the island and subsurface data farther west indicate that the Beaufort Formation forms an elongate wedge paralleling the Arctic coast and thickening to the northwest, locally to about 500 m. Beaufort strata lie unconformably on various sedimentary rock formations and are overlain by a veneer of gravel with boulders that forms an upland plain sloping at 1 to 3 m/km towards the Arctic coast.

The wedge of Beaufort deposits described above for Prince Patrick Island extends northeast and southwest along the islands bordering the Arctic Ocean, from Banks Island to Meighen Island. Different types of deposits are included, but braided river facies similar to those on Prince Patrick Island are widespread.

3256 DEWING, K., COPPER, P., and HAMILTON, S.M. (1987)

Preliminary report on the stratigraphic position of oil shales in the Lower Paleozoic of Southampton Island, N.W.T.; in Current Research, Part A, Geol. Surv. Can., Paper 87-1A, pp. 883-888.

Two black oil shales were examined on Southampton Island during fieldwork carried out in July 1986. The first, 3.5 m thick, is part of the Boas River Shale unit and is exposed on the Boas River between the Bad Cache Rapids and Churchill River groups. It has an abundant Pseudogygites fauna indicating a Late Caradoc to Early Ashgill (Cobourg-Maysville) age. The second, exposed at 16 Mile Brook, is a discontinuous, 24 cm thick black shale directly below the conformable contact between the Red Head Rapids and Severn River formations. The algal-laminated and algal-biothermal Red Head Rapids Formation is interpreted as a restricted hypersaline facies of the Early Silurian lower Severn River Formation.

3257 DIXON, J. (1986)

Comments on the stratigraphy, sedimentology and distribution of the Albian Sharp Mountain Formation, northern Yukon; in Current Research, Part B, Geol. Surv. Can., Paper 86-1B, pp. 375-381.

The early Albian Sharp Mountain Formation of the Keele Range, northern Yukon, was originally described as a shallow water, marine to alluvial deposit. New outcrop trends are identified and four facies assemblages described: conglomerate, conglomerate-sandstone, sandstone and shale. The sedimentological attributes of these facies favour an origin as sediment gravity flow deposits in basinal areas. Deposits of similar origin in the Blow Trough to the north and the Kandik Basin to

the southwest indicate that, during the early Albian, basinal conditions extended throughout much of northern Yukon.

3258 DIXON, J. (1988)

Depositional setting of the Maastrichtian Cuesta Creek Member, Tent Island Formation, northern Yukon; in Current Research, Part D, Geol. Surv. Can., Paper 88-1D, pp. 61-65.

Early descriptions and interpretations of the depositional setting of the Maastrichtian Cuesta Creek Member, Tent Island Formation, identified the clastics as fluvial deposits prograding over prodelta sediments. Some of the clastics were attributed to braided river deposition. The facies types, sedimentary structures and regional setting favour a drastic revision of the original interpretations. The generally thin bedded nature of the succession, small- to large-scale scours, Bouma-type cyclothems, debris-flow-type deposits and a lack of sedimentary structures produced by traction currents all point to an origin as sediment-gravity flow deposits on a submarine fan.

3259 DIXON, O.A. (1986)

Variability in heliolitid corals and the problem of species definition; Abstract in 21st Annual Meeting, Northeastern Section, Geol. Soc. America, March 12-14, 1986, Klamesha Lake, New York, Abstract with Programs, Vol. 18, No. 1, p. 13.

The corallum of a heliolitid coral is a compound $CaCO_3$ skeleton with a variety of physical attributes that can usefully be appraised both qualitatively and quantitatively. Assessing morphological variability, both within and between coralla, is an important consideration in systematic study of these corals, as it is with many other coral groups. Each corallum was produced by a colony of genetically identical individuals derived vegetatively from a single initial larva. Each corallum, therefore, shows variability related both to individual ontogeny and to colony astogeny. The colonial skeleton importantly documents the response of the colony to environmental changes throughout the life of the colony. Each corallum differs somewhat from all others of the species due to a combination of environmental, genetic and evolutionary variation. Biocharacters that can be shown to be less variable in response to environmental change, have greater potential use in species definition and discrimination.

Qualitative description and graphical representation of biometric data together have been effective in defining limits of variation and demarcating what appear to be natural groups in the heliolitid genera studied. These groups are taken to be species, although some vary considerably more than others. Taxonomic treatment of these groups requires consideration of a literature in which more than 80 generic names and hundreds of trivial names have been attributed to heliolitid corals. A large proportion of previously named species are monotypic or are based on too few specimens to allow adequate assessment of morphological variability. Species defined on assemblages, therefore, can be difficult to accommodate in existing nomenclature, although they can be the basis for revising and simplifying it.

3260 DIXON, O.A., BOLTON, T.E., and COPPER, P. (1986)

Ellisites, an Upper Ordovician heliolitid coral intermediate between Coccoserids and Proporids; Paleontology, Vol. 29, Part 2, pp. 391-413.

The Upper Ordovician heliolitid corals Ellisites labechioides gen. et sp. nov. and E. astomata (Flower) combine vesicular skeletal plates with zones of strongly dilated vertical trabeculae. In these characters they provide the first evidence of a phylogenetic link between the Coccoseridicae and Proporicae. They are referred to a new family, the Ellisitidae, and included in the Coccoseridicae, which necessitates taxonomic modification of the latter to include genera with vesicular skeletal plates. They show features most related to Coccoseris Eichwald, 1855, and to two of three species considered to have been erroneously referred to the stromatoporoid Dermatostroma Parks, 1910. Their substantially vesicular skeletal development can lead them to be mistaken for strongly cystose labechiid stromatoporoids.

3261 DYKE, A.S. (1987)

A reinterpretation of glacial and marine limits around the northwestern Laurentide Ice sheet; Can. J. Earth Sci., Vol. 24, No. 4, pp. 591-601.

Seven new radiocarbon dates pertaining to deglaciation of northern Prince of Wales Island place the margin of the Laurentide Ice Sheet on the island by 11 000 BP. This requires a revision of the proposed age for the Viscount Melville Sound Ice Shelf of 10 300 - 9880 BP. A revised age of 11 300 - 11 000 BP is suggested.

The new dates also require revisions of the proposed Wisconsinan and Holocene history of Banks Island. Shells thought to have been thrust onshore to an elevation of 88 m by the ice shelf on northern Banks Island after 10 600 BP are reinterpreted as undisturbed postglacial marine shells recording a relative sea level of 88 m or more. This, in turn, suggests that the East Coast Sea and Jesse Till are of Late Wisconsinan rather than Early Wisconsinan age and that the Late Wisconsinan glacial limit on Banks Island as figured on the 1968 Glacial Map of Canada, rather than on recent revisions, is essentially correct.

3262 DYKE, A.S., and MORRIS, T.F. (1988)

Drumlin fields, dispersal trains, and ice streams in Arctic Canada; The Canadian Geographer, Vol. 32, No. 1, Canadian landform Examples, Chapter 7, pp. 86-90.

Drumlin fields, or swarms of hills streamlined in the direction of glacier flow, are common elements of glaciated landscapes. Most are believed to have formed a short distance behind the ice margin just prior to deglaciation and therefore record the final direction of ice movement. Dispersal trains are long and relatively narrow belts of glacial debris of some distinctive composition transported down-ice from a source region. Ice streams are linear zones of rapidly flowing ice within an ice sheet flanked by ice moving much more slowly. They are important features of the present Greenland and Antarctic ice sheets, where they account for more than half the ice sheet drainage. They are now being recognized in the former Laurentide Ice Sheet.

3263 DYKE, A.S., and PREST, V.K. (1987)

Late Wisconsinan and Holocene history of the Laurentide Ice Sheet; Géographie physique et Quaternaire, Vol. XL1, No. 2, pp. 237-263.

Eleven paleogeographic maps and a summary ice retreat map outline the history of advance, retreat, and readvances of the Laurentide Ice Sheet along with associated changes in proglacial drainage and relative sea level oscillations for Late Wisconsinan and Holocene times. The text outlines pertinent chronological control and discusses the paleoglaciology of the ice sheet, with attention to location and migration of ice divides, their attendant domes and saddles, and to ice streams, ice shelves, and mechanisms of deglaciation. At 18 ka the ice sheet consisted of 3 sectors with an interlocked system of ice divides joined at intersector saddles. A thoroughgoing superdivide is recognized and named in the Trans Laurentide Ice Divide. The ice sheet retreated slowly from 18 to 13 ka, mainly along the west and south margins, but still held a near maximum configuration at 13 ka. A regional change in flow pattern over the Prairies just before 14 ka is thought to represent a large reduction in ice volume, but not in extent, and likely was triggered by a switch from nondeforming to deforming bed conditions. Retreat between 13 and 8 ka was vastly more rapid in the west than in the east, which resulted in eastward migration of the divide system of Keewatin Ice but relatively static divides of Labrador and Foxe Ice. By 10 ka the Trans Laurentide Ice Divide had been fragmented as Hudson Ice became increasingly autonomous. By 8 ka Hudson Ice had disappeared, little ice was left in Keewatin, but Foxe Ice still held its near maximum configuration and Labrador Ice was still larger than Foxe Ice. Repeated surging along aquatic margins and calving back of margins thinned by surging probably was the most important mechanism of deglaciation of Keewatin and Hudson Ice. The core of Foxe Ice disintegrated at 7 ka but retreat and readvance of Foxe Ice remnants continued throughout the Holocene.

3264 DYKE, L.D. (1984)

Frost Heaving of Bedrock in Permafrost Regions; Bull. Assoc. Engineering Geologists, Vol. XXI, No. 4, pp. 389-405.

Frost heaving of bedrock in permafrost areas is a widespread process that produces a variety of landforms and exhibits movements of possible concern to engineering endeavours. While the study of ice growth in soils is an actively researched subdiscipline of soil mechanics, the same process in rock escaped notice until major engineering projects were considered in areas outside the dominantly soil covered parts of the North American arctic.

Geology and hydrology exert a fundamental control on the style of the rock heave process. Displacement of single blocks, panels, and domes has taken place where saturated zones in the active layer became confined by the downward-advancing freezing front. The attempted expulsion of water by continued freezing supplies the heaving force, much in the manner of the closed-system pingo. This mechanism is favoured where the water table lies close to the surface in the massive granites, gneisses, and quartzites of the Canadian Shield. The mechanism requires that ice-filled cracks be able to seal in high pore water pressures. Field measurements show that water pressures up to 400 kPa are attained within the confined water bodies, a pressure considerably in excess of that needed to offset the overburden pressure.

Where drier conditions prevail and rocks less resistant to weathering are present, the accumulation of weathering products in cracks can provide a site for heaving. In this case, the forces are produced by the growth of segregated ice in soil-filled cracks. This mechanism is common in sandstones and limestones and contributes to the mechanical breakdown of outcrops. Laboratory experiments confirm that horizontal movements can be produced by vertically-downward freezing in vertical soil-filled cracks. This mechanism is widespread because saturated conditions are not necessary.

Resurveying of markers at several locations from Churchill, Manitoba to the central Arctic Islands reveals yearly movements of up to 5 cm, horizontally and vertically. Recorded movements are most common at sites subject to the ice segregation mechanism. Vertical movements tend to be cyclical due to settlement during thaw. Features formed by the water expulsion mechanism presumably reach an equilibrium height and show little further movement.

3265 EDLUND, S.A. (1986)

Map showing surficial materials, Bathurst Island area and Byam Martin Island, District of Franklin, N.W.T. (1:250 000), Geol. Surv. Can., Open File No. 1275.

One unedited map at a scale of 1:250 000 shows the types of surficial materials and their distribution on Bathurst, Cameron, Ile Vanier, Massey, Alexander, and Byam Martin islands, and the Berkley Group. The terrain is dominated by weathered bedrock. Other major Quaternary deposits include littoral marine deposits and think, scattered glacial deposits, primarily on the uplands, although more substantial deposits occur locally.

3146 EDLUND, S.A. (1986)

Vegetation-geology-climate relationships of western Melville Island, District of Franklin; in Current Research, Part A, Geol. Surv. Can., Paper 86-1A, pp. 719-726.

3266 EGGINTON, P.A., and FRENCH, H.M. (1985)

Solifluction and related processes, eastern Banks Island, N.W.T.; Can. J. Earth Sci., Vol. 22, No. 11, pp. 1671-1678.

Mean surface soil movement measured over the period 1972-1983 on eight relatively low angle (<10°), well drained slopes on eastern Banks Island averaged 0.6 cm/year. Substantial variation in mean movement was recorded amongst the slopes. The variation relates to differences in soil moisture conditions, soil grain size, and the position of the measurement transect relative to the crest or base of the slope. The former two variables and therefore the rate of movement can change rapidly across any given slope, particularly when stripes are present.

Three types of movement are identified in the study area: (1) mud burst and mud flow; (2) classic solifluction; and (3) pluglike flow. The latter occurs along discrete shear planes located both within and at the base of the active layer. The existence of episodic and relatively rapid mass movement on these slopes suggests that long-term monitoring programs are necessary to adequately assess and measure the slope movement.

3267 EISENSTADT, G. (1988)

Structural evaluation of Ellesmerian Tectonics, Central Ellesmere Island; Abstract in, Proc. GAC, MAC, CSPG Joint Annual Meeting, May 23-25, 1988, St. John's, Newfoundland, Program with Abstracts, Vol. 13, p. A36.

The major difficulty in unravelling the nature of the Ellesmerian Orogeny in the Canadian Arctic is the overprint of Tertiary Eurekan deformation. Eurekan structures follow roughly the same trend as earlier Ellesmerian folds. Caledonian Bay, Ellesmere Island, is one of the new places in the Canadian Arctic where both Franklinian and Sverdrup Basin rocks are exposed together. Detailed mapping (1:12,000) and analysis of minor structures during 1987 was aimed at separating the effects of the two orogenies and evaluating tectonic models.

There are basically two scenarios for Ellesmerian deformation: one proposes a large-scale sinistral shear zone that may have extended from Svalbard to Alaska; the other suggests a direct collision between the Siberian Platform and North America. Analysis of field data shows that Ellesmerian deformation was locally intense that there is no evidence of left-lateral movement in this area. The minor structures reflect a complex history of basin extension and inversion and provide a useful tool for larger-scale tectonic synthesis.

3268 EMBRY, A.F. (1985)

Stratigraphic subdivision of the Isachsen and Christopher formations (Lower Cretaceous), Arctic Islands; in Current Research, Part B, Geol. Surv. Can., Paper 85-1B, pp. 239-246.

The Isachsen Formation, a Lower Cretaceous sandstone-dominant unit, is herein divided into three members, named in ascending order: Paterson Island, Rondon and Walker Island. The Paterson Island and Walker Island members are sandstone-dominant units of delta front and delta plain origin and are separated by the shale-siltstone-dominant Rondon Member, which is of offshore marine shelf origin. The Christopher Formation, a Lower Cretaceous, shale-siltstone-dominant unit, which overlies the Isachsen Formation, is divided into two members, named in ascending order: Invincible Point and Macdougall Point. Both members are of offshore marine shelf origin, and the boundary between the two is placed at the top of a widespread sandstone-siltstone interval that occurs in the middle of the Christopher Formation.

3269 EMBRY, A.F. (1985)

New stratigraphic units, Middle Jurassic to lowermost Cretaceous succession, Arctic Islands, in Current Research, Part B, Geol. Surv. Can., Paper 85-1B, pp. 269-276.

Bajocian to Valanginian strata (Middle Jurassic to lowermost Cretaceous) in the southern and western portions of the Sverdrup Basin consist of alternating units of shale-siltstone and sandstone. The stratigraphic nomenclature for these strata is well established in this area, and the only addition proposed in this paper is the formalization of a previously recognized sandstone member in the argillaceous Deer Bay Formation, herein named the Glacier Fiord Member. To the north and west, the sandstone units disappear due to facies change and the entire succession consists of siltstone and shale. This thick shale-siltstone

unit is herein named the Mackenzie King Formation. In some areas, the formation can be divided into three members - McConnell Island, Ringnes and Deer Bay - all of which have formation status in the southeastern Sverdrup Basin.

3270 EMBRY, A.F. (1986)

Stratigraphic subdivision of the Blind Fiord and Bjorne formations (Lower Triassic), Sverdrup Basin, Arctic Islands; in Current Research, Part B, Geol. Surv. Can., Paper 86-1B, pp. 329-340.

The Blind Fiord Formation is a Lower Triassic shale/siltstone unit that occurs within the Sverdrup Basin. The formation is divisible into three members, formally named in ascending order: Confederation Point, Smith Creek, and Svartfjeld. Each member consists predominantly of shale in its lower portion and siltstone in its upper portion.

The Bjorne Formation is a sandstone-dominant unit that occurs on the basin margins, and is stratigraphically equivalent to the Blind Fiord Formation. Along the eastern and southeastern basin margins two shale/siltstone units occur within the formation, allowing five members to be recognized. The sandstone-dominant members are formally named in ascending order: Cape Butler, Pell Point and Cape O'Brien. The intervening shale/siltstone members are correlated with the Smith Creek and Svartfjeld members.

The stratigraphic nomenclature reflects the occurrence of three major transgressive-regressive cycles in the Lower Triassic of Sverdrup Basin.

3271 EMBRY, A.F. (1986)

Stratigraphic subdivision of the Awingak Formation (Upper Jurassic) and revision of the Hiccles Cove Formation (Middle Jurassic), Sverdrup Basin, Arctic Islands; in Current Research, Part B, Geol. Surv. Can., Paper 86-1B,. pp. 341-349.

The Awingak Formation is a sandstone-dominant unit of Oxfordian to Tithonian (Late Jurassic) age and it occurs in the eastern and southeastern portion of the Sverdrup Basin. Throughout most of its extent, three members can be recognized within the formation: a lower sandstone, a medial shale/siltstone, and an upper sandstone. These three members are given formal status and are named, in ascending order: Cape Lockwood, Hot Weather and Slidre members.

Correlation of the three members of the Awingak Formation and the underlying Ringnes Formation with sections on western Melville Island and Prince Patrick Island, has revealed that strata previously assigned to the upper portion of the Hiccles Cove Formation are stratigraphically equivalent to the Ringnes Formation and the Cape Lockwood Member of the Awingak Formation. In order to achieve a consistent stratigraphic nomenclature for the Middle-Upper Jurassic succession of the Sverdrup Basin, the upper boundary of the Hiccles Cove Formation is redefined to exclude strata equivalent to the Ringnes and Awingak formations from the Hiccles Cove.

3272 EMBRY, A.F. (1988)

Mesozoic paleogeography, Arctic North America; Abstract in, Proc. GAC, MAC, CSPG Joint Annual Meeting, May 23-25, 1988, St. John's, Newfoundland, Program with Abstracts, Vol. 13, p. A36.

From Early Triassic to Middle Jurassic Arctic North America was occupied by a sinuous seaway which extended from northern Greenland, through the Canadian Arctic Islands, Chukchi Sea and northern Alaska, to the northern Yukon. The seaway was flanked by low lying landmasses which provided abundant clastic sediment.

In early Middle Jurassic the tectonic setting and paleogeography were significantly altered by the initiation of the Amerasian Basin by rifting. By Late Jurassic the rift extended southward from Lomonosov Ridge to the Mackenzie Delta and was flanked by uplifted rift shoulders and shallow seaways. Rifting and crustal stretching intensified in Early Cretaceous and volcanism was widespread in the northern portion of the rift and adjacent areas. A rising orogenic belt occupied northern Alaska and a thick clastic wedge prograded northeastwards in the adjacent foreland basin.

Uplift in the earliest Late Cretaceous coincided with crustal separation and the formation of oceanic crust in the Amerasian Basin. The ocean expanded throughout Late Cretaceous with the anticlockwise rotation of northern Alaska and adjacent Siberia away from the Canadian Arctic Islands. Alpha Ridge formed as a hot spot track during this time. Initial deposits on the adjacent continental areas were bituminous shales followed by thick clastic wedges which prograded into the ocean basin. Widespread uplift occurred at the end of the Mesozoic when rifting and sea floor spreading switched to the Eurasian Basin.

3273 EMBRY, A.F. (1988)

Phanerozoic geology of the Canadian Polar Margin; Abstract in, Proc. GAC, MAC, CSPG Joint Annual Meeting, May 23-25, 1988, St. John's, Newfoundland, Program with Abstracts, Vol. 13, p. A36.

The interpreted geological framework of the Canadian Polar Margin is based on three sources of data: geophysical surveys, extrapolation of the onshore geology, and empirical and theoretical models of the development of the Amerasian Basin. Lower Paleozoic rocks of the Franklinian Mobile Belt underlie the entire margin but vary greatly along its length. Gently tilted strata occur in the south, folded and faulted clastics are present in the central portion, and highly deformed,

metamorphosed and intruded rocks occur in the north. Upper Paleozoic to Middle Jurassic strata are absent from much of the shelf due to late Jurassic to Cretaceous uplift and erosion with only thin remnants occurring on the inner portion of the northern half of the shelf.

The margin was initiated in Middle Jurassic with the start of rifting in the Amerasian Basin. Middle Jurassic to lowermost Cretaceous clastics likely occur at the base of graben successions in outer shelf and slope locations. Thick successions of Lower Cretaceous clastics, deposited during the main rifting phase of the Amerasian Basin, are interpreted to be present in grabens in the mid-shelf area and possibly seaward.

In Late Cretaceous, the Amerasian Basin expanded by sea floor spreading and a seaward-thickening wedge of Upper Cretaceous clastic strata was deposited on the subsiding margin. Volcanism was restricted to the northern portion of the margin and occurred from Middle Jurassic to latest Cretaceous. Paleogene clastic strata prograded seaward along the margin and thicken northward as well as seaward. On the northern portion of the shelf the strata were mildly deformed by the Eocene-Oligocene Eurekan Orogeny. A thick undeformed wedge of Neogene strata is present along the length of the margin.

3274 ENGLAND, J. (1985)

On the origin of high arctic fiords; Abstract in 14th Arctic Workshop, Arctic Land-sea interaction, Nov. 6-8, 1985, Dartmouth, N.S., pp. 51-53.

During the past three decades it has been widely assumed that the fiords and interisland channels of the Queen Elizabeth Islands represent an ancient, dendritic river system developed during the Tertiary on a contiguous landmass. This landmass would have included mainland Canada and Greenland which may have been the source areas for the streams. It was proposed further that these Tertiary channels were overdeepened by subsequent glacial erosion during the Quaternary. Indeed, not only are the channels assumed to be the result of glacial overdeepening but, in turn, they are used to support the presence of an Innuitian Ice Sheet occupying the Queen Elizabeth Islands during the last glaciation. On the other hand, research on northern Ellesmere Island provides an alternative model for the nature of the last glaciation in the eastern Queen Elizabeth Islands and together with related observations, this warrants a reconsideration of the origin of these high arctic fiords.

3275 ENGLAND, J. (1985)

The late Quaternary history of Hall Land, northwest Greenland; Can. J. Earth Sci., Vol. 22, No. 10, pp. 1394-1408.

The last ice limit on Hall Land, northwest Greenland, is marked by the Newman and Petermann moraines, which were deposited 40-60 km beyond the present ice margins in Newman Bay and Petermann Fiord, respectively. These moraines flank the eastern and western coasts of Hall Land but do not extend into its intervening central plain. As a result of glacioisostatic depression at this time, a full glacial sea transgressed the entire central plain via a narrow estuary located between the Newman Moraine and the northern plateau of Hall Land. The limit of this full glacial sea is isostatically tilted from 116 m asl on the adjacent coast of Ellesmere Island to 150 m asl on the southwest extremity of the central plain, where it reaches its apex. Pervasive marine silts cover the central plain and laterally thicken towards the Newman and Petermann moraines. Because of the height of the full glacial sea, these moraines were deposited in a submarine environment and mark the grounded margins of ice shelves floating in Hall Basin and Newman Bay.

Twenty-seven samples of marine pelecypods from the proximal and distal sides of these moraines were ^{14}C dated. Distal to the moraines the limit of the full glacial sea is dated by in situ shells that range from 8200 to >33 000 BP. During this interval relative sea level remained stable and the ice load was apparently in isostatic equilibrium. Initial emergence (unloading) throughout the full glacial sea (~8200 BP) coincides with the initial penetration of the sea inside the Newman Moraine dated at 7965 BP and inside the Petermann Moraine at 8280 and 8295 BP.

This research concludes that (1) there was no Nares Strait ice ridge during the last glaciation; (2) ice retreat of only 40-60 km can cause 140-150 m of emergence, and (3) the deglaciation of northwest Greenland began at 8000 and not 10 000 BP. This research confirms that the relative sea-level curves from the adjacent coast of Ellesmere Island were isostatically dominated by the Greenland Ice Sheet.

3276 ENGLAND, J. (1986)

Glacial erosion of a High Arctic valley; J. Glaciology, Vol. 32, No. 110, pp. 60-64.

A large valley, ideally suited for "selective linear erosion" by ice, extends from the Kreiger Mountains to Tanquary Fiord, north-central Ellesmere Island. During the last glaciation, the outlet glacier at the head of the valley advanced 18 km and was at least 250 km thick where is contacted the sea in the lower valley. Erosion of bedrock inside the last ice limit is recorded by an abraded diabase dike, and by crag-and-tail features developed in limestone. During deglaciation (7800 B.P.), melt-water streams along the ice margin incised a large alluvial fan that pre-dates the last glaciation. The fan shows little alteration by the overriding ice and its final erosion by the melt-water streams incised, but did not remove, its original ice-wedge polygons.

The preservation of the fan indicates that the glacier was locally non-erosive and that it probably advanced across the fan by overriding a protective frontal ice apron. Although it is commonly assumed that such alluvial fans occupying glaciated valleys are of post-glacial age, this need not be the case in permafrost terrain. In fact, at this site, there has been a net increment of alluvium versus glacial erosion or deposition spanning the last glacial cycle. The paper discusses the processes of erosion associated with sub-polar glaciers and questions whether erosion by them or more pervasive ice is responsible for such High Arctic valleys and fiords.

3277 ENGLAND, J. (1986)

A Paleoglaciation level for north-central Ellesmere Island, N.W.T. Canada; Arctic and Alpine Res., Vol. 18, No. 2, pp. 217-222.

The present-day glaciation level and equilibrium-line altitude (ELA) for inner Greely Fiord, north-central Ellesmere Island, are ca. 900 m asl. During the last glaciation, the paleo-ELA was $\leq$400 m asl whereas the maximum paleoglaciation level was ca. 475 m asl. Although the glaciation level and ELA dropped by as much as 500 m during the last glaciation, the extent of ice was nonetheless very limited, generally within 5 to 40 km of present margins. Consequently, this area was characterized by severe continentality; i.e., greater summer cold and similar, if not greater, aridity. These greatly constrained glaciers, particularly those that entered the sea and calved.

At Eureka, 170 km southwest of inner Greely Fiord, recent changes in the mean height of the July freezing level are strongly correlated with the ELA on the White Glacier, Axel Heiberg Island. There, the ELA has lowered from 900 to 400 m asl in some years. This recent lowering of the ELA to 400 m asl on the White Glacier is similar to the ELA reported for inner Greely Fiord during the last glaciation, yet both are still less severe than present conditions on northernmost Ellesmere Island where the ELA is ca. 200 m asl.

3278 ENGLAND, J. (1987)

The late Quaternary history of Hall Land, northwest Greenland: Reply; Can. J. Earth Sci., Vol. 24, No. 2, pp. 374-380.

After 10 years of fieldwork on the Quaternary geology of northeast Ellesmere Island, it was concluded that the Ellesmere Island and northwest Greenland ice sheets did not coalesce during the last glaciation and that the intervening marine channels were occupied by a full glacial sea. Furthermore, the delevelling of postglacial shorelines on northeast Ellesmere Island indicates a strong upward displacement towards the Greenland Ice Sheet, whose history of deglaciation (unloading) must be recorded by the pattern of post-glacial emergence from the full glacial sea. Numerous radiocarbon dates on northeast Ellesmere Island show that initial emergence, and therefore deglaciation, began around 8000 BP. In order to test the validity of the Ellesmere Island model it was essential to visit the adjacent coast of Hall Land where previously published accounts suggested a different sequence of events.

3279 ENGLAND, J. (1987)

Glaciation and the evolution of the Canadian high arctic landscape; Geology, Vol. 15, pp. 419-424.

The Canadian arctic islands represent a Tertiary fluvial landscape developed on a contiguous landmass subsequently fractured by block faulting. Nonetheless, some theoretical models invoke pervasive high-latitude ice sheets and continue to misattribute the faulted landscape to glacially scoured river valleys. Quaternary fieldwork on northern Ellesmere Island suggests that these models are inappropriate for high-latitude ice sheets and should be abandoned. If there was ever a regional ice sheet over arctic Canada, it likely occurred on a prefaulted, contiguous landmass that had a more temperate climate than at present, possibly during the late Tertiary. After block faulting, the marine channels permanently prevented the ice from inundating the landscape it once crossed. Tectonics, and not climate, have led to a fundamental change in glacial style. This block faulting also may have played a role in terminating the late Tertiary boreal forest (to ~80°N) by establishing cold marine channels that diminished the continentality of the once-contiguous landmass. For a thorough understanding of the Canadian arctic landscape, future research should determine the continuity between the Tertiary and Quaternary paleoenvironments. The unknown ages of the fiords and interisland channels are of primary importance.

3280 ENGLAND, J., and BEDNARSKI, J. (1986)

Postglacial isobases from northern Ellesmere Island and Greenland: new data; Geographie physique et Quaternaire, Vol. XL, No. 3, p. 209-305.

Over seventy new ^{14}C dates on former relative sea levels from Hall Land, northwest Greenland, and Clements Markham Inlet, northern Ellesmere Island, are combined with previous data to revise the regional isobases for this area. These isobases show: (1) a centre of maximum postglacial emergence over northwest Greenland extending to; (2) an intervening cell of lower emergence over northeast Ellesmere Island which was isostatically-dominated by the Greenland Ice Sheet; in turn, extending to; (3) a higher centre of emergence over the Grant Land Mountains, northernmost Ellesmere Island, associated with the independent history of local ice caps there. Radiocarbon dates from raised marine shorelines show a 2000 year lag between glacial unloading on northwest Greenland and northernmost Ellesmere Island. This lag in glacioisostatic adjustments suggests a

considerable range in the glacier response times and/or glacioclimatic regimes in this area. Throughout the area the last ice limit was ca. 5-60 km beyond present ice margins. Maximum emergence at these ice limits is marked by shorelines built into a full glacial sea which range from 124 m asl in Clements Markham Inlet to 150 m asl in Hall Land. This indicates that similar emergence (120-150 m) in other areas does not necessarily require the removal of entire ice sheets although this has been commonly assumed in the literature. The geophysical implications of this warrant consideration.

3281 ENGLAND, J., and STEWART, T.G. (1985)

Isotope geochemistry of stratified Lake "A", Ellesmere Island, N.W.T., Canada: Discussion; Can. J. Earth Sci., Vol. 22, No. 4, pp. 647-648.

We would like to comment on the conclusions presented by Jeffries et al. in their recent paper. Our principal concern regards what was omitted from their final paragraph concerning possible paleo-environmental implications of their data.

3282 FERLING-METZLER, A., REDEKER, H.-J., and STÖFFLER, D. (1986)

Petrography, shock metamorphism, excavation and uplift of the 1700 m deep crystalline basement of Haughton Dome crater, Canada; in Proc. 49th Annual Meeting of the Meteoritical Society, New York, N.Y., pp. 22-25.

The Haughton Dome impact structure, a complex 20 km diameter crater, is located in a stratified target which consists of about 1700 m of Cambrium to Silurian sedimentary rocks on top of a Proterozoic crystalline basement. Shocked basement rocks occur as large blocks in the center of the structure and as clasts within a polymict allochtonous breccia layer covering most of the central area of the crater up to a radial distance of nearly 6 km. Detailed chemical (XRF), REM, and microscope analyses were made on a representative collection of 24 crystalline rock samples larger than about 5-10 cm size. In addition, small clasts of crystalline rocks <ca. 1 cm in size were studied of 34 samples of polymict fragmental breccias regarding the frequency distribution and degree of shock. The following 10 rock types were observed: sillimanite gneiss, garnet-sillimanite-gneiss, garnet-bearing gneiss, calcite-diopside gneiss, apatite-rich hornblende gneiss, apatite-rich biotite gneiss, aplitic gneiss, tonalitic ortho-gneiss, amphibolite, and basalt. The locations of these rocks within the breccia layer are given in Figure 1. Their chemical characteristics and the normative composition are shown in Figure 2. Except for the tonalitic orthogneiss which is unshocked and probably represents an erratic block displaced by glaciers, all large crystalline rocks samples belong to shock states I, II and III which cover the shock pressure range from about 15 to 60 GPa. The percentages of rocks in each of the shock stages are 22, 22, and 56%, respectively (total: 23 samples). The variation in the degree of shock is somewhat larger in the population of small clasts of the polymict breccia because not only unshocked or very weakly shocked rocks of stage 0 (<10 GPa) are present but also unshocked plagioclase, quartz and microcline clasts were found. Some of this quartz is derived from noncrystalline rocks (sandstones) of higher stratigraphic levels. Four types of polymict breccias have been recognized which differ in the abundance of crystalline rock clasts and other properties. Two types whose groundmass is rich in gypsum and calcite, respectively, are extremely poor in crystalline rock components. The penetration depth of a stony meteorite (25 km/sec) and the pressure decay as calculated is compatible with the observed depth of excavation (d~2 km) and the degree of shock. Using empirical formulae, the final crater diameter of Haughton is calculated to be in the 22-25 km range.

3283 FORBES, D.L., and FROBEL, D. (1985)

Coastal erosion and sedimentation in the Canadian Beaufort Sea; in Current Research, Part B, Geol. Surv. Can., Paper 85-1B, pp. 69-80.

Sediments are supplied to the Beaufort Sea coast primarily from river and cliff sources. Mackenzie Delta is the major depositional feature, but has a predominantly erosional outer shoreline, despite high sediment supply and locally wide mudflats revealing sediment sink locations. Other features include cliffs, breached-lake embayments, flooded tundra flats, lagoons, estuaries, deltas, beaches, and barriers. Coastal surveys during 1984 included extensive oblique aerial video coverage, 22 beach profiles at 8 sites, sediment sampling, and 98 measurements of cliff recession at 11 sites. Beach deposits range from cliff-top gravels (up to 6.0 m above mean sea level) and gravel barriers (up to 2.2 m) to wide sandy spits and barrier islands with crest elevations as low as 0.4 m. Driftwood deposits occur as high as 6.0 m. Observed rates of cliff recession show high spatial and temporal variability, with 5-year means as high as 13 m/a.

3284 FORBES, D.L., TAYLOR, R.B., and FROBEL, D. (1986)

Coastal studies in the western Arctic Archipelago (Melville, Mackenzie King, Lougheed and nearby islands); Geol. Surv. Can., Open File 1409, Cruise Report 86302, 29 p.

Coastal studies in the northwestern Arctic Archipelago during the summer of 1986 were divided into two components. Phase 1, on Sabine Peninsula, northern Melville Island, was concerned with Holocene delta sedimentation, facies characteristics in river-mouth settings, prodelta slope stability, and rates of fluvial sediment supply to the coast. Delta terrace sequences were surveyed and sampled along the lower reaches of three of

the largest rivers in the area, with observations extending up to about 30 m asl near Invincible Point, 27 m asl near Drake Point, and 20 m asl near Chads Point. A preliminary assessment of the relative sea level history in the area suggests that the deposits examined may provide information on delta sedimentation processes back to 8-9 ka BP. Phase 2, based on Lougheed Island, was intended to ground-truth coastal mapping carried out in 1980 and based exclusively on airphotos, to extend the information base by examining type coastal settings on Lougheed Island, and to extend and improve oblique aerial video coverage of the coast in this region. Low-level video imagery was obtained for the entire coast of Lougheed and nearby small islands and for much of the east and north coast of Mackenzie King Island. The ground-truth survey program encompassed 11 sites on Lougheed Island and 2 on Mackenzie King.

3180 FORSYTH, D.A., MOREL-À-L'HUISSIER, P., ASUDEH, I., and GREEN, A.G. (1986)

Alpha Ridge and Iceland-products of the same plume?; J. Geodynamics, Vol. 6, pp. 197-214. CESAR Contr. No. 30.

3181 FORSYTH, D.A., ASUDEH, I., GREEN, A.G. and JACKSON, H.R. (1986)

Crustal structure of the northern Alpha Ridge beneath the Arctic Ocean; Nature, Vol. 322, No. 6077, pp. 349-352.

3150 FRANCIS, J.E., and McMILLAN, N.J. (1987)

Fossil Forests in the Far North; GEOS, Vol. 16, No. 1, pp. 6-9.

3285 FRENCH, H.M. (1984)

Some Terrain and Land-Use Problems Associated with Exploratory Wellsites, Northern Yukon Territory; in Northern Ecology and Resource Management, ed. R. Olson et al., Univ. Alberta Press, pp. 365-436.

Few studies describe the terrain, permafrost, and vegetation conditions of the interior northern Yukon. Even with the opening of the Dempster Highway in 1979, large areas of the territory are still inaccessible. The present paper adds to this literature by describing terrain disturbances associated with several exploratory wellsites in the northern Yukon. The operations described here cover a period during which companies were gaining experience in working in permafrost conditions, researchers were gaining knowledge on terrain sensitivity, and regulators were learning how to set controls to minimize disturbance.

3286 FRENCH, H.M. (1985)

Surface Disposal of Waste Drilling Fluids, Ellef Ringnes Island, N.W.T.: Short-Term Observations; Arctic, Vol. 38, No. 4, pp. 292-302.

An experimental procedure by which waste drilling fluids were placed upon the tundra was undertaken at the Panarctic Dome et al. Hoodoo N-52 wellsite on Ellef Ringnes Island during the early winter of 1981-82. Preliminary site investigations indicated ice-rich permafrost conditions and the potential for extensive terrain disturbance if a sump were constructed. During the summer of 1982 seepage of waste effluent away from the disposal area occurred, and a quantity of muds and supernatant waters entered an adjacent creek. Water-quality analyses indicated that leaching of heavy metals was slow in the short term and soluble components were quickly diluted to background levels. The major toxicity threat posed by drilling wastes is primarily one of high salinity. The low level of terrain disturbance associated with a sumpless operation is a major advantage of such a procedure.

3287 FRENCH, H.M. (1986)

Periglacial involutions and mass displacement structures, Banks Island, Canada,; Geogr. Am., Vol. 68A, No. 3, pp. 167-174.

Deformed structures occurring in terrace deposits of the Bernard River, central Banks Island, are interpreted as soft-sediment deformations, the result of rapid sedimentation and entrapment of excess pore water. Other deformed structures described from terrace deposits of the Kellett River, southern Banks Island, are thought to have resulted from liquifaction and density re-adjustments in the active layer. Since permafrost conditions were involved in the latter, these structures can reasonably be termed periglacial involutions.

The presence of both soft-sediment deformations and periglacial involutions in a present periglacial environment emphasises the difficulty of interpreting involutions in Pleistocene sediments of mid-latitudes.

3288 FRENCH, H.M. (1986)

Focus: permafrost geomorphology; The Canadian Geographer, Vol. 30, No. 4, pp. 358-366.

Permafrost geomorphology and periglacial geomorphology are intimately linked. The latter developed in Europe, mainly as a branch of climatic geomorphology. It sought to understand the geomorphic processes and landforms of cold non-glacial regions and to use that understanding in the reconstruction of Pleistocene and Quaternary environments. Two criteria that identify peri-

glacial regions are the existence of intense freezing and thawing of the ground, either on a seasonal or a diurnal basis, and the formation and preservation of perennially frozen ground, or permafrost.

In Canada, where permafrost underlies approximately 50 percent of the land surface, and where virtually no areas are unaffected by frost action, periglacial geomorphology is a modern branch of process geomorphology. As in the Soviet Union, where the peculiarities of frozen ground have been known for several centuries, periglacial geomorphology in Canada should be regarded as an integral component of permafrost science, or geocryology. Accordingly, the term permafrost geomorphology rather than periglacial geomorphology is adopted here.

3289 FRENCH, H.M. (1987)

Permafrost and Ground Ice; in Human Activity and Environmental Processes; eds. K.J. Gregory and D.E. Walling, John Wiley & Sons Ltd., Chichester, England, Chapter 10, pp. 237-269.

Permafrost, or perennially frozen ground, influences virtually all aspects of man's activities in the regions which it underlies. In North America, the importance of permafrost was realized only relatively recently, when attention focused on Alaska and other northern regions during and immediately after the Second World War. The building of the Alaskan Highway in 1942 from Dawson City to Fairbanks and the construction of the Carol pipeline from Norman Wells to Alaska in 1943 were major engineering undertakings which highlighted the inadequacies of traditional methods of construction. In addition, the difficulties of water and sewage provision, and the limitations placed on agriculture and mining by permafrost meant that large-scale permanent settlement of Arctic North America was unrealistic until permafrost problems were understood.

The Soviet Union, by virtue of its longer history of settlement in permafrost regions, was aware of these problems earlier than other countries and by the late 1920s had established a Permafrost Institute of the Siberian Academy of Sciences at Yakutsk in Eastern Siberia. This institute now employs several hundred permafrost scientists. The nearest equivalent in North America is the Cold Regions Research and Engineering laboratory (CRREL) of the US Army, located at Hanover, New Hampshire.

3290 FRENCH, H.M. (1987)

Periglacial processes and landforms in the Western Canadian Arctic; in Periglacial processes and landforms in Britain and Ireland; ed. J. Boardman, Cambridge University Press, Cambridge, England, pp. 27-43.

On the basis of climate, topography and Quaternary history, a number of contemporary periglacial environments can be recognized in Western Arctic Canada. These include (a) polar desert and semi-desert regions of the High Arctic islands; (b) ice-rich tundra lowlands of the Mackenzie Delta and Yukon Coastal Plain; (c) unglaciated British and Ogilvie Mountains; (d) unglaciated interior pediments of Old Crow Basin; and (e) unglaciated interior uplands of Klondike (Yukon) Plateau. While no one region provides a convincing and complete analogue for the periglacial conditions which the British Isles experienced during the Pleistocene, each provides insight upon the roles played by lithology and moisture availability in determining the efficacy of cryogenic processes and the variability of permafrost conditions.

3291 FRENCH, H.M. (1987)

Periglacial geomorphology in North America: current research and future trends: Ecol. Bull., Vol. 38, pp. 5-16.

Periglacial geomorphology in North America is a rigorous branch of process geomorphology with important applied applications. Since frost action and permafrost are central themes, periglacial geomorphology must be regarded as part of the science of geocryology. Current research problems include the cryogenic weathering of bedrock, frost heave and ice segregation, the nature and origins of ground ice, and active layer processes.

3292 FRENCH, H.M. (1988)

Active Layer Processes; in Advances in Periglacial Geomorphology, ed. M.J. Clark, John Wiley & Sons Ltd., Chichester, England, pp. 151-177.

Until recently the processes relating to the thermal and physico-mechanical properties of the active layer, in both its thawed and frozen states, were little known but in the last fifteen years the necessity to plan, design and construct major engineering structures in permafrost areas has led to significant advances in our understanding. The thermal regime is geomorphologically important, especially during the thaw and freezing periods. Important recent advances include an improved awareness of two-sided freezing, and of the significance of unfrozen water in freezing and frozen soils. Processes associated with these thermal and moisture drives are ground ice segregation, frost heave and the upfreezing of objects. Taken together, these processes produce mass wasting (considered here) and the formation of patterned ground and frost mounds (considered in subsequent chapters). Within the active layer itself, thaw consolidation contributes to the explanation of rapid mass movements and low-angle slope instability. There is still contention concerning certain aspects of the active layer, and some processes such as cryoturbation remain under debate.

3293 FRENCH, H.M., and HARRY, D.G. (1983)

Ground Ice Conditions and Thaw Lakes, Sachs River Lowlands, Banks Island, Canada; in Mesoformen des Reliefs im heutigen Periglazialraum, Mathematisch-Physikalische Klasse, Abhandlungen der Akademie der Wissenschaften in Göttingen, Dritte Folge Nr. 35, Göttingen Vanderhoeck & Ruprecht, pp. 70-81.

The Sachs River lowlands are underlain by ice-rich silty and sandy sediments of late-Quaternary age. Ground ice constitutes approximately 60% of the upper 8.0 m of permafrost. Stratigraphic studies of sediments beneath drained lakes in this area indicate that basin development occurred as a result of the thermokarst subsidence of ice-rich permafrost terrain. This interpretation is based upon (a) the 'compressed' stratigraphy beneath the basin, (b) the reduced ice contents of these sediments and, (c) the relationship between observed basin depth and potential thaw subsidence of adjacent terrain. Radiocarbon age determinations indicate that many of the thaw lakes were initiated between 8,000-9,000 B.P., corresponding to an early phase of the mid-Holocene climatic optimum.

3294 FRENCH, H.M., and HARRY, D.G. (1988)

Nature and origin of ground ice, Sandhills Moraine, southwest Banks Island, Western Canadian Arctic; J. Quaternary Science, Vol. 3, pp. 19-30.

The Sandhills Moraine is a Late Wisconsinan lateral moraine complex on southwest Banks Island. The occurrence of ice-ablation landforms, ground ice slumps, kettle lakes and catastrophic lake drainage in winter suggests the presence of substantial bodies of massive ground ice. The distinctive hummocky topography of the Sandhills Moraine is thought to reflect partial melt-out of this ice. Stratigraphic observations indicate that the ice is overlain irregularly and unconformably by glaci-genic sediments, notably pebbly clay (till) and/or sandy gravels (outwash), while the ice itself possesses numerous and variable mineral inclusions, faults and foliations. Petrofabric analyses indicate a strongly preferred orientation to the ice crystals. It is suggested that these characteristics are best explained if the ground ice is interpreted as relict glacier ice.

3295 FRENCH, H.M., and POLLARD, W.H. (1986)

Ground-ice investigations, Klondike District, Yukon Territory; Can. J. Earth Sci., Vol. 23, No. 1, pp. 550-560.

Massive bodies of ground ice, 2.0-4.0 m thick, are regularly exposed in small placer mining operations in the Klondike District, Yukon. At Hayes claim, Hunker Creek, the ice is underlain by 2.0-3.0 m of creek gravels and overlain by 10.0-15.0 m of organic-rich and ice-rich much deposits. The crystallographic and petrographic characteristics of the ice and its stratigraphic occurrence suggest that the ice body either had a segregation origin or was a residual snowbank subsequently buried by muck deposits and recrystallized.

3296 FRENCH, H.M., BENNETT, L., and HAYLEY, D.W. (1986)

Ground ice conditions near Rea Point and on Sabine Peninsula, eastern Melville Island; Can. J. Earth Sci., Vol. 23, No. 9, pp. 1389-1400.

Using data obtained in the winter of 1981-1982 from trench excavations in the vicinity of Rea Point, volumetric ice contents with depth have been calculated for Paleozoic age (Weatherall, Griper Bay, and Hecla Bay formations) and Quaternary age (alluvium and deltaic sands) sediments. In addition, borehole data from Sabine Peninsula and observations from the Panarctic Sherard Bay exploratory wellsite sump in the late winter of 1982-1983 enable similar values to be calculated for Mesozoic age (Christopher Formation) sediments. Although these data are believed typical of large areas of eastern Melville Island, they are only first estimates, since considerable site-specific variability may be present. Shale of the Christopher Formation possesses the highest ice content, typically between 30 and 70% by volume throughout the profile. Weatherall and Griper Bay siltstones and sandstones also contain locally significant ice contents (50-70%) at depths of 0.5-1.5 m. Pore and segregated ice are the dominant ice types. Ice-wedge is a relatively insignificant component of total ice content in any of the sediments examined.

3180 FORSYTH, D.A., MOREL-A-L'HUSSIER, P., ASUDEH, I., and GREEN, A.G. (1986)

Alpha Ridge and Iceland-products of the same plume? J. Geodynamics, Vol. 6, pp. 197-214, CESAR Contr., No. 30.

3181 FORSYTH, D.A., ASUDEH, I., GREEN, A.G., and JACKSON, H.R. (1986)

Crustal structure of the northern Alpha Ridge beneath the Arctic Ocean; Nature, Vol. 322, No. 6077, pp. 349-352.

3297 FRISCH, T. (1987)

Granulite-facies analogues of I-S-type granitoids in the northernmost Canadian Shield, Arctic Canada; Abstract in, Proc. International Sym. on Granites and Associated Mineralizations (ISGAM), January 21-31, 1987, Salvador, Bahia, Brazil, p. 157.

The northernmost part of the Canadian Shield, exposed in southeastern Ellesmere Island and eastern Devon Island, is a transitional granulite

terrane consisting of late Archean (?and early Proterozoic) ortho - and paragneisses and ca. 1900 Ma granitoids ranging from quartz norite to K-feldspar-rich granite. The granitoid bodies - particularly abundant on Ellesmere Island - are moderately to strongly deformed and commonly have gradational or indefinite contacts with their host rocks. However crosscutting relations and inclusions of country rock, locally present, confirm the intrusive origin of the granitoids.

The characteristics of the granitoids of Ellesmere and Devon islands invite comparison with the granitoids of the Paleozoic Lachlan fold belt of southeastern Australia. There, the hinterland region of thickest crust (possibly representing a former continental margin) is crowded with intrusions of peraluminous S-type granites interspersed with greatly subordinate hornblende-bearing I-type bodies. The exposed S-type granites occur as high-level bodies in volcanic and low-grade metamorphic rocks and many contain muscovite, in addition to garnet, cordierite and/or sillimanite. In contrast, the high-grade host rocks and orthopyroxene of the Ellesmere-Devon granitoids reflect a deeper, "drier" environment of crystallization.

3298 FRISCH, T. (1988)

Reconnaissance geology of the Precambrian Shield of Ellesmere, Devon and Coburg islands, Canadian Arctic Archipelago; Geol. Surv. Can., Memoir 409, 102 p., 4 maps.

The extensively ice- and snow-covered highland areas of southeastern Ellesmere Island, eastern Devon Island and Coburg Island are underlain by highly deformed granulite facies rocks of the northernmost Canadian Shield. The bulk of the terrane comprises a late Archean or early Proterozoic continental margin sequence now made up of garnet-sillimanite-cordierite gneiss, marble, quartzite, quartzofeldspathic gneiss of calc-alkaline composition, and metabasalt chemically of oceanic affinity, in interleaved belts trending northerly on Ellesmere and Coburg islands, easterly on Devon island.

These rocks were intruded by a granitoid suite under granulite facies conditions between 1.9 and 2.0 Ga. Orthopyroxene-bearing tonalitic to granitic rocks, retrograded to varying degree, from especially extensive terranes in the southern and northern parts of the shield on Ellesmere Island. Xenolith-rich peraluminous granite with garnet, cordierite and/or sillimanite is abundant on Ellesmere Island. Most, if not all, of the intrusions are thought to have originated by crustal anatexis related to the granulite facies metamorphism and are moderately to strongly deformed.

Pressures and temperatures of metamorphism range from 7 to 3 x 10^5 kPa and about 750 to 500°C, largely reflecting decompression and cooling during uplift. Pressures recorded in Devon Island rocks are generally higher than elsewhere in the map area.

The interleaving of belts of diverse lithologies, the high metamorphic grade, and significant partial melting are probably due to crustal thickening by thrust stacking, possibly resulting from continental collision.

The crystalline rocks are overlain on the east coast of Ellesmere Island by unmetamorphosed sediments and basalts of the Neohelikian Thule Group and are bordered on the west and north by lower Paleozoic strata of the Arctic Platform.

3299 FRISCH, T., ANNESLEY, I.R., and GITTINS, C.A. (1985)

Geology of the Chantrey Belt and its environs, Lower Hayes River and Darby Lake map areas, northern District of Keewatin; in Current Research, Part A, Geol. Surv. Can., Paper 85-1A, pp. 259-266.

The map area is underlain by Archean? gneissic rocks of plutonic origin and northeast-trending belts of supracrustal and granulite facies rocks.

Lower amphibolite grade metasediments of the Aphebian? Chantrey Group form a syncline 5 km wide and 175 km long. Marginal shallow-marine carbonate and quartzitic rocks are overlain by either fine grained metapelite/psammite, quartzite and dark, pyritic schist or, locally, metaconglomerate. Coarse andalusite is a common porphyroblast in pelitic rocks. Two periods of folding have severely deformed the Chantrey Group and its contact with basement is strongly sheared, with local overthrusting of basement.

Another supracrustal belt, of the same metamorphic grade but intruded by granite, comprises pelitic and metavolcanic rocks and subordinate Chantrey-type marble, quartzite and metaconglomerate.

A 10 km-wide belt of granulite facies rocks in southeastern Lower Hayes River area consists of garnetiferous gneisses and meta-intrusive garnet-orthopyroxene granite.

3300 FRISCH, T., and HUNT, P.A. (1987)

New data on the age of the Precambrian Shield of Ellesmere and Devon islands, Arctic Archipelago; Abstract in, Program and Abstracts, the Canadian Arctic Islands, Canada's Missing Dimension, an International Meeting Sponsored by the National Museum of Natural Sciences, November 21-24, 1987, Ottawa, Canada, pp. 20-21.

The largely ice- and snow-covered highland regions of southeastern Ellesmere Island and eastern Devon Island are underlain by high-grade metamorphic rocks of the Churchill Structural Province of the Canadian Shield. Gneisses and metasediments, metamorphosed in the granulite facies at a depth of 20-25 km at temperatures of 750 to 800°C

(possibly higher locally), are intruded by a variety of mafic to felsic, orthopyroxene-bearing granitoid bodies, which are themselves commonly gneissic. Field relations suggest that intrusion, granulite facies metamorphism and major deformation were not widely separated in time.

Geochronological information has been obtained mainly by U-Pb isotopic analysis of zircon and monazite. For most of the rocks, unambiguous interpretation of the results is hindered by complexities in the zircons, such as multi-stage growth of crystals - a consequence of the involved geological history of the terrane - and a high uranium content, which promotes severe disturbance of the U-Pb system. Nevertheless, several important conclusions regarding the geological evolution of the area can be drawn.

Interlayered orthopyroxene tonalite gneiss and granite gneiss from southern Devon Island give zircon concordia ages of 2,518 +56/-33 and 2,428 +36/-31 million years, respectively (i.e. latest Archean - earliest Proterozoic). Zircon ages from variably gneissic, orthopyroxene-bearing granitoid rocks intrusive into similar gneisses and metasediments on Ellesmere Island range from 1,972 + 41/-36 to 1,951 +12/-11 million years and are interpreted as indicating magmatic emplacement about 1.96 billion years ago. Monazite from two of these rocks gives almost concordant ages around 1.93 billion years, which is considered to be a minimum for high-grade metamorphism and deformation.

Zircon from a small, massive body of monzonorite intrusive into marble at Cape Isabella, eastern Ellesmere Island, yields an essentially concordant age of 1,912 ± 1.6 million years. A comparable but less well constrained zircon age of 1,912 +21/-11 million years from anatectic granite, derived by partial melting of aluminous paragneiss, provides further evidence of magmatic activity following the metamorphic-deformational climax - possibly as a result of pressure drop during uplift.

In summary, the results suggest the presence of Archean crust on Devon Island, intrusion of granitic magma in Ellesmere Island about 1.96 billion years ago, closely followed by granulite-grade metamorphism and deformation, and subsequent (uplift-related?) melting prior to 1,900 million years ago.

3301 FROBEL, D., TAYLOR, R.B., and FORBES, D.L. (1987)

Video applications in coastal research; in Proc. Canadian Coastal Conference, July 7-10, 1987, Quebec, P.Q., Assoc. Committee for Research on Shoreline Erosion and Sedimentation, Nat. Res. Council, NRCC-27810, pp. 429-436.

At the Atlantic Geoscience Centre (AGC), video tape recording equipment has been used primarily to obtain continuous, aerial oblique imagery of the Canadian coastline. This is particularly useful in frontier areas, such as the Arctic, where in many areas, the most recent conventional vertical air photo coverage dates back to the late 1950's. During the past three years, more than 7000 km (59 h) of coastal imagery has been collected in Atlantic and Arctic Canada, using both rotary and fixed-wing aircraft flying at roughly 100-150 m (325-500 ft) altitude and 100-150 km/h (50-80 knots). Simultaneous commentary adds navigational control, focuses attention on specific features and provides field observations of nearshore bedforms and sediments, as well as features that may have been missed by the video camera. Video taping has also been used at ground level, to monitor temporal variations in wave run-up and sedimentation, and at sea on towed, remotely operated and manned underwater vehicles, to document seafloor morphology and sediment types.

Video editing the computer graphics facilities at AGC have enabled the production of a number of presentations for education and reference purposes and the release of the low-level airborne imagery for parts of the Arctic Archipelago, Beaufort Sea and western Newfoundland as Geological Survey of Canada open files. Imagery for other parts of Arctic and Atlantic Canada will be released in the future.

3302 FUJINO, K. (1985)

An Outline of the Research Project, "Characteristics of the Massive Ground Ice Body in the Western Canadian Arctic Related to Paleoclimatology; in Characteristics of the Massive Ground Ice Body in the Western Canadian Arctic Related to Paleoclimatology, 1984-1985, ed. K. Fujino, Inst. Low Temp. Sci., Hokkaido Univ., Japan, pp. 1-8.

Data on ground ice have accumulated rapidly in recent years as a result of increasing oil explorations in the Arctic coastal region. Now available, for example, are data of several thousands holes drilled for proposed pipeline routes as well as those of many tens of thousands of shot-holes drilled for seismic explorations in the permafrost region. Many of them are given in great details and have provided information on ground ice including massive ground ice bodies, distribution and stratigraphic structure.

According to drill-hole records, thick, tubular and irregular bodies with much ice underlie the extensive area of the western Arctic coastal plain, especially east of Hershel Island, in the Mackenzie Delta and around Tuktoyaktuk Peninsula.

Commonly known as a typical periglacial ground feature such as pingo, ice wedge and patterned ground, the massive ground ice body can be observed in numerous coastal exposure throughout the Mackenzie - Beaufort region.

Massive ground ice bodies are distinctive in topographic feature. Their bodies have generally a relatively flat top and steep sides, contrasted with the pingo, which has a conical feature, and rises 15 to 20 metres above the surrounding terrain. Thickness of the ice bodies ranges from

several meters to about 45 m, the maximum thickness reported to date, and the horizontal extent of them ranges from several tens of meters to over 2 km in length and 0.5 km^2 to 2.0 km^2 in area[3]).

3303 FUJINO, K., and SATO, S. (1985)

Stratigraphic Analyses of the Massive Ground Ice Body in Tuktoyaktuk, Mackenzie Delta, N.W.T.,Canada; in Characteristics of the Massive Ground Ice Body in the Western Canadian Arctic Related to Paleoclimatology, 1984-1985, ed. K. Fujino, Inst. Low Temp. Sci., Hokkaido Univ., Japan, pp. 9-36.

Massive ground ice bodies are one of the typical periglacial ground features in the Arctic region. However, their origin and formation processes are still arguable. There are three following hypotheses are their origin: (1) snow-glacial/buried ice; (2) syngenetic ice wedges; (3) segregated ice. Among these three, the ice segregation hypothesis which has been proposed by Mackay has been supported by many scientists in this field.

During the joint research expeditions of 1977, 1980, 1981 and 1982, the present authors found that the mechanism of its growth is not identical to that of the growth of the pingo in which segregated ice constitutes the core. And from the observations of ice fabrics and geochemical and stratigraphic analyses, it was concluded that the most parts of the massive ice body originate from superimposed ice formed by congelation of water in which it was submerged.

For obtaining more detailed information on massive ground ice bodies, the research project was carried out with geophysical, geochemical and geological conceptions in August 1984 and March 1985.

In this paper, authors report the results obtained from analyses of the stratigraphic features of the overlying till and ice body together with ice fabrics and pollen grains.

3304 FUJINO, K., SATO, S., MATSUDA, K., SASA, K., SHIMIZU, O., and KATO, K. (1988)

Characteristics of the Massive Ground Ice Body in the Western Canadian Arctic (II); in Proc. Fifth International Conf. on Permafrost, August 2-5, 1988, Trondheim, Norway, Poster Presentation A2.7.

Massive ground ice bodies are one of the typical ground features in the Arctic region. However, their origin and formation processes are still arguable. The present authors' findings from observations of the ice core obtained through the massive ice body are opposite to the segregated ice origin.

Ice crystals in each stratum of the core were distinctly different in size, shape, C-axis orientation and air bubble distribution. Strata of granular ice crystals, which constitutes more than one half of the entire core, were considered to be superimposed ice from their crystallographic features and babble distribution. Fine Tindal figures which formed by internal melting from solar radiation observed in some strata of the ice core.

Sediments contained in layers between adjacent ice strata consisted of sand, clay/silt or their mixture and had various forms. Most of them abounded in fossil pollen grains which were different from those in the till layer overlying the ice body. Some of the grains were considered to have been transported in the air, not eroded out from rocks. Striations in the ice body were out by the basal plane of the sediment overlying it and the unconformity formed between them.

Profiles of chemical compositions in the ice body also showed distinct changes corresponding to the discontinuities of ice fabrics.

From these results obtained, we conclude that most parts of the ice body which lies on the sand layer formed by superimposed ice. And the sediment between strata of ice was formed at an ablation stage of the ice body. Through intermittent repetitions of ablation and accumulation processes, the ice mass developed with recognizable strata which correspond to the discontinuities in ice fabrics and chemical compositions.

3305 GALLEY, A.G., JACKSON, G.D., and IANNELLI, T.R. (1983)

Nechelikian subaerial basalts with ocean-floor type chemistry, northwestern Baffin Island; Abstract in Geol. Assoc. Canada, Program with Abstracts, Vol. 8, p. A25.

Basalt flows of the Nauyat Formation (1.2 Ga) are 360 m thick, and are interbedded with fluvial to intertidal quartzarenite. The Nauyat is the basal formation of the Bylot Supergroup and unconformably overlies an Archean-Aphebian metamorphic complex. Present distribution of the flows is spatially related to northwest trending faults which were active during filling of the Borden Basin. Columnar jointing, oxidized amygdaloidal flow tops, associated sedimentary rocks and underlying sialic basement indicate a subaerial continental setting.

The basalt flows are quartz-hypersthene normative tholeiites, low in Ti and high in Si and Na. Chemical parameters are similar to those for ocean floor basalts. High ^{87}Sr ratios and high concentrations of incompatible elements are taken to be the result of contamination by sialic crust. The Nauyat flows probably represent the initial stages of continental rifting.

Volcanic flows and/or sills of similar age, chemistry and geologic setting occur in Somerset Island, north of Fury and Hecla Strait, in the Thule Group about northern Baffin Bay, and in the

Zig Zag Dal Formation of northeastern Greenland. The Coppermine volcanics are believed by others to be continental plateau basalts originating from mantle plume activity. The combination of Neohelikian plume- and rift-type basalt emplacement on the northwestern edge of the Canadian-Greenlandian Shield may be related to the opening of the Proto-Arctic Ocean.

3306 GIBBINS, W.A. (1983)

Arctic Islands Region; in Mineral Industry Report 1978, Northwest Territories, Chapter III, Indian & Northern Affairs, Yellowknife, N.W.T., EGS-1983-2, pp. 27-33.

The Arctic Archipelago includes all or parts of several major geological provinces. Precambrian rocks of the Canadian Shield are exposed in the Minto Arch, Boothia Uplift, and Baffin Island and form a crystalline basement under much of the younger sedimentary cover. The north-trending Cornwallis Fold Belt, which divides the Arctic Platform and Franklin Geosyncline into eastern and western parts, developed mainly in Silurian and Devonian time in response to periodic faulting caused by movements of the Boothia Uplift. The Sverdrup Basin, which in late Proterozoic and Mesozoic time was superimposed on the folded Franklin Geosyncline, was itself folded in the Cenozoic. Relatively undisturbed Proterozoic sediments occur in several parts of the Arctic Islands, notably Northern Baffin, Victoria, Somerset and Ellesmere Islands.

3307 GIBBINS, W.A. (1983)

Arctic Islands Region; in Mineral Industry Report 1979, Northwest Territories, Chapter 3, ed. J.A. Brophy, Indian & Northern Affairs, Yellowknife, N.W.T., pp. 53-67.

3308 GIBBINS, W.A. (1984)

Arctic Islands Region; in Mineral Industry Report 1980/81, Northwest Territories, Chapter 3, eds. J.A. Brophy and C.E. Ellis, Indian & Northern Affairs, Yellowknife, N.W.T., EGS-1984-5, pp. 83-130.

3309 GIBBINS, W.A. (1984)

Mississippi Valley type lead-zinc districts of northern Canada; in Contributions to the geology of the Northwest Territories, Vol. 1, ed. J.A. Brophy, Indian & Northern Affairs, Yellowknife, N.W.T., EGS-1984-6, pp. 95-106.

Mississippi Valley type (MVT) deposits account for all of the lead, zinc, cadmium and a significant amount of the silver currently produced in Northern Canada. This production comes from deposits associated with a Middle Devonian barrier reef complex of the Pine Point District, the Polaris deposit in Ordovician Thumb Mountain Formation in the Cornwallis Lead-Zinc District and the Nanisivik deposit in Helikian (Proterozoic) Society Cliffs Formation on Northwestern Baffin Island. The Cordillera of Northern Canada contains important undeveloped MVT deposits in the Robb Lake, Gayna River, Bonnet Plume River and Godlin Lakes districts.

These deposits can all be related to major structural elements, (basement structures and/or unconformities) extensive shale source rocks and solution breccia or karst development. Hydrocarbons, evaporites and dolomitization are generally present, but have variable aspects.

Future exploration successes are most likely in known districts and extensions of these districts. IP, EM, gravity and geochemistry ("zinc-zap") have been successful exploration techniques in the Pine Point, Nanisivik, Cornwallis and Mackenzie Mountain areas respectively. Other areas with geological potential, but very little exploration to date, are the carbonates of the Franklin Miogeosyncline (Ellesmere Island), the Northern Interior Plains, and the Clyde River Fold Belt of the Central Baffin Island. Potential for MVT deposits is more uncertain in carbonates of the Arctic Platform (Brodeur Peninsula of Northwestern Baffin Island and Victoria and Banks Islands of the Western Arctic) and cratonic basins, the Foxe Basin and in the Northern Hudson Bay Basin (southern and western Southampton Island).

3310 GIBBINS, W.A. (1985)

Arctic Islands Region; in Mineral Industry Report 1982-83, Northwest Territories, Chapter 4, ed. J.A. Brophy, Indian & Northern Affairs, Yellowknife, N.W.T., pp. 95-155.

3311 GIBBINS, W.A. (1987)

Arctic Islands Region; in Mineral Industry Report 1984-85, Northwest Territories, Chapter 4, ed. C.E. Ellis, Indian & Northern Affairs, Yellowknife, N.W.T., EGS-1984-85, pp. 55-92.

3312 GIBBINS, W., BOUCHER, D., and SKUBLAK, W. (1986)

Fluorite from Princess Royal Islands: Historic and Possible Economic Significance; Arctic, Vol. 39, No. 1, pp. 89-91.

Armstrong, physician and naturalist assigned to McClure's Investigator (1949-52), reported garnet, a typically metamorphic mineral, in unmetamorphosed rocks of Princess Royal Islands. During recent visits to these islands a few crystals of purple fluorite were found near the northeast tip of the smaller, northernmost island. However, no garnet was found on either island.

3313 GOOD, T.R., and BRYANT, I.D. (1985)

Fluvio-aeolian sedimentation - an example from Banks Island, N.W.T., Canada; Geogr. Ann., Vol. 67A, No. 1-2, pp. 33-46.

Sedimentary processes and recent sediments are described from the lower course of the Sachs River, Banks Island and from adjacent sandflats. The river is characterised by a short period, annual spring flood which deposits a hierarchy of superimposed bedforms in the high-stage river channel. In the early part of the melt season ephemeral stream action also occurs on the sandflats adjacent to the river. The fluvial deposits of the ephemeral streams and the channel are subject to the aeolian modification during the subsequent arid summer months such that interbedded fluvio-aeolian sediments accumulate.

The presence of permafrost restricts the depth of aeolian reworking so that ripples and climbing adhesion structures are the typical aeolian bedforms whilst laterally persistent, planar deflation surfaces are ubiquitous in sections through the sandflats.

These observations have been integrated to produce a local model of fluvio-aeolian sedimentation which is characterised by channel fills and sediments deposited as aeolian sandsheets which are truncated by deflation surfaces.

3314 GOODBODY, Q.H. (1985)

Stratigraphy, sedimentology, and paleontology of the Bird Fiord Formation, Canadian Arctic Archipelago; unpub. Ph.D. thesis, Dept. Geology, Univ. Alberta, 405 p.

The Lower to Middle Devonian Bird Fiord Formation on Ellesmere Island is overlain by, and, to the east, interdigitates redbeds of the Strathcona Fiord Formation. These redbeds are replaced on western Grinnell Peninsula and Bathurst Island by sandstones of the Hecla Bay Formation. On Ellesmere Island north of the axis of the Schei syncline, the Bird Fiord Formation is underlain by limestones of the Blue Fiord Formation which are transitional to dolostones of the Blue Fiord/Disappointment Bay Formation on the south limb of the Schei syncline. On Grinnell Peninsula and eastern Bathurst Island the Bird Fiord Formation overlies unnamed dolomitic limestones whereas on central and western Bathurst Island it overlies, and interdigitates with, shales and siltstones of the Cape De Bray Formation.

Six informal members (A-F) constitute the Bird Fiord Formation. On the south limb of the Schei syncline between Arthur Fiord and Baad Fiord the formation is 550 meters thick and comprises four members (A - evaporites, dolostones and minor amounts of limestone; B - impure limestones; C and D - interbedded shales, siltstones and sandstones). These members resulted from deposition in A/ sabkha and carbonate mudflats; B/ lagoonal and nearshore carbonate shelf settings; C/ a proximal clastic shelf setting, and D/ paralic and deltaic environments. North of Grise Fiord the uppermost part of the formation (member E) is composed of fluvial sandstones. A synsedimentary structural hinge coincident with the axis of the Schei syncline produced a stratigraphic thickening and facies deepening to the north. At Bird Fiord the formation (800 m thick) is composed of members F and D. Member F comprises five units, the lower four are composed of mixed carbonates and clastics representing lagoonal and littoral environments; unit 5 comprises prodelta silts deposited distal to the overlying shallow marine/?fluvial? sandstones of member D. Only member D is correlatable across Schei syncline.

The Bird Fiord Formation thickens westerly from 600 m on Grinnell Peninsula (Devon Island) to 900 m on central Bathurst Island. Members C and D are laterally variable between Ellesmere Island, Grinnell Peninsula and Bathurst Island; west of Arthur Fiord these members comprise the entire formation. Member C is divided into a lower unit (rhythms 50-100 m thick) representing distal shelf deposition, and an upper unit (rhythms 3-6 m thick) representing more proximal shelf deposition. Member C is overlain by proximal shelf and paralic clastics (member D unit 1) capped in turn by delta margin deposits (member D unit 2).

The Bird Fiord Formation represents the introduction of clastic sediments into a regime previously dominated by carbonate facies. The transitional deposits of the Bird Fiord Formation herald the change over from marine to littoral and continental facies. This facies change commenced in the eastern Arctic in late Emsian to early Eifelian time and progressed westward across the Arctic Islands during the Middle Devonian.

The distribution of the formation is mapped on a scale of 1:250,000, with stratigraphic, sedimentologic and paleontologic data presented in cross sections, lithologic columns and pie/stratigraphic diagrams. The brachiopod fauna is illustrated. Large fossil collections complementing the sedimentological investigations show variation in faunal composition with relative position on the shelf and with changes in substrate.

3315 GRAF, G.C. (1988)

Carbonate mudmound complexes of the Upper Silurian Douro and Barlow Inlet Formations at Gascoyne Inlet, Devon Island, Arctic Canada; unpub. M.Sc. thesis, Univ. Ottawa, 163 p.

Mudmound complexes and intermound facies occur in the topmost Douro Formation and lowermost Barlow Inlet Formation in a transition sequence up to 66.4 m thick. The transition sequence is superbly exposed in cliffs at Gascoyne Inlet on southwestern Devon Island.

A pre-mudmound sequence consists of up to 16.9 m of rubbly limestone intercalated with 4 resistant ancolite-rich packstone/wackestone units. The uppermost unit is overlain by mudmounds and

mudmound complexes. The latter are mound- to pinnacle-like and show no preferred orientation. The complexes are up to 52.2 m thick and comprise a sparsely fossiliferous core, crinoidal flankbeds and a stromatoporoid bindstone cap. Intermound sediments consist of a basal rubbly limestone abruptly overlain by the crinoidal flankbeds, in turn overlain by well bedded mudstones and marls that are capped by laterally discontinuous stylopleurid biostromes. The post-mudmound sequence consists of crinoidal grainstones, fossiliferous wackestones and packstones, reefoid buildups and stromatoporoid biostromes of the basal Barlow Inlet Formation.

Paleoecologic and sedimentologic studies indicate that the mudmound complexes developed on a carbonate ramp, on storm-transported sediments in subtidal, low energy conditions above storm wave base. Cryptalgal fabrics and sponges suggest that the predominant mound constructors were algae and sponges. With upward growth into shallower, more agitated conditions crinoids, tabulate corals and to a lesser degree rugose corals played a more active role in mound construction. Extensive crinoidal flankbeds developed and at this time the mudmounds had about 4 m relief. During development of the crinoidal flankbeds, the mudmounds grew above fair weather wave base. The presence of a hardground in one mudmound complex overlain by an irregular, sparsely fossiliferous unit which is in turn overlain by a unit containing a predominantly stromatoporoid biota suggests significant changes in environmental conditions. Dramatic reduction of flankbeds above the hardground surface and pressure of coeval fine grained mudstone/marl in intermound localities indicate an initial decrease in energy probably related to deepening. A medial to proximal foreslope setting is consistent with the observed facies relationships and this compares with similar facies in the Barlow Inlet Formation on Cornwallis Island. Stylopleurid biostromes developed over the entire sequence and probably formed in the ramp equivalent of a proximal foreslope setting. Influx of fine grained sediment largely as periplatform ooze could have reduced the growth potential of the stromatoporoids to the point where sediment deposition exceeded growth of the stromatoporoids, resulting in the demise of the mudmound complexes.

Conditions of sedimentation changed abruptly as deposition of the transition sequence ended: turbidity was substantially reduced and mud deposition was succeeded by carbonate production in association with benthic communities. This resulted in development of extensive overlying reefs and biostromes.

3316 GRAF, G.C., and DIXON, O.A. (1986)

Carbonate mudmounds in an Upper Silurian ramp/shelf transition at Gascoyne Inlet, Devon Island, Arctic Canada; Abstract in GAC, MAC, CGU Joint Annual Meeting, May 19-21, 1986, Carleton Univ., Ottawa, Program of Abstracts, Vol. 11, p. 75.

A 40 m thick sequence consisting of mudmound complexes and intermound sediments occurs in the Douro/Barlow Inlet transition sequence on southwestern Devon Island. Cliff exposures indicate that the mudmounds are randomly scattered, are moundlike in geometry and have no preferential orientation. They are up to 40 m thick and comprise a sparsely fossiliferous micrite core, crinoidal flankbeds and an irregular stromatoporoid bindstone cap. In intermound areas a basal rubbly limestone (mudstone and wackestone) is abruptly overlain by the mudmound crinoidal flankbeds. These are in turn overlain by well bedded mudstones.

Paleoecologic and sedimentologic studies indicate that the mudmounds initially developed on storm-transported sediments in subtidal, low energy conditions above storm wave base. With upward growth of the mounds into shallower, more agitated conditions, extensive crinoidal flankbeds developed. At this time, the mudmounds had a relief of about 4 m and intermound sediments were predominantly debris shed off the mounds. A subsequent relative deepening produced more open marine conditions and resulted in growth of stromatoporoids on the mound tops. The improved circulation may have increased transport of fine sediments to intermound areas and these sediments eventually onlapped and terminated the mounds.

3317 GRAF, G.C., and DIXON, O.A. (1987)

Carbonate mudmounds in an Upper Silurian ramp/shelf transition of Gascoyne Inlet, Devon Island, Arctic Canada; Abstract in, CSPG Canadian Reef Research Sym., January 27-30, 1987, Banff, Alberta, Program with Abstracts, p. 85.

A 40 m thick sequence consisting of mudmound complexes and intermound sediments occurs in the Douro/Barlow Inlet transition sequence on southwestern Devon Island.

Cliff exposures of the mudmounds in the 4 sq. km study area indicate that these structures are moundlike in geometry and show no preferential orientation. The pre-mudmound sequence consists of 16 m of rubbly limestone intercalated with 4 resistant wackestone/packstone units that contain assorted bioclasts. The uppermost resistant unit is directly overlain by the mudmounds. The mudmounds are up to 40 m thick and comprise a sparsely fossiliferous micrite core, crinoidal flankbeds and an irregular stromatoporoid bindstone cap. Intermound sediments consist of a basal rubbly limestone abruptly overlain by mudmound crinoidal flankbeds. These are in turn overlain by well bedded mudstones. The post-mudmound sequence consists of more resistant crinoidal grainstones, fossiliferous wackestones and packstones, reefoid buildups and stromatoporoid biostromes.

Paleoecologic and sedimentologic studies indicate that the mudmounds initially developed on storm transported sediments in subtidal, low energy conditions above storm wave base on a carbonate

ramp. Cryptalgal fabrics and sponges suggest that the predominant mound constructors were of an algal/sponge assemblage. With upward growth into shallower, more agitated conditions crinoids, tabulate corals and to a lesser degree rugspan corals began to play a more active role in mound construction. Extensive crinoidal flankbeds developed and at this time the mudmounds had a relief of about 4 m. The change to a predominantly stromatoporoid biota suggests a change in environmental conditions on the mound tops, possibly improved water circulation and agitation. This improved circulation may have increased transport of fine sediments to intermound areas with these sediments eventually onlapping and terminating the mounds. Turbidity was then substantially reduced and mud deposition was succeeded by carbonate production in association with benthic communities. This resulted in extensive reef and biostrome development.

3318 GRIEVE, R.A.F. (1988)

The Haughton Impact Structure: Summary and Synthesis of the Results of the HISS Project; Meteoritics, Vol. 23, No. 3, pp. 249-254.

Surface and subsurface structural studies undertaken under the Haughton impact structure study (HISS) project indicate that the 23 Ma-old Haughton impact structure, (Devon Island, Canadian Arctic) consists of a central basin of uplifted strata, an inner zone of uplifted megablocks at 3.5-5.5 km radius, a complex, faulted annulus of megablocks at 5.5-7.0 km radius and an outer zone of downfaulted blocks. No evidence of a previously suggested structural multi-ring form was found. The geophysical studies suggest an original diameter of 24 km, slightly larger than previous estimates and the seismic data indicate considerably more faulting in the western portion than has been mapped from surface exposures. Detailed studies of the allochthonous breccia deposits found no major radial variations in lithology and shock levels. The only anomaly is the concentration of highly shocked, cobble-sized clasts in the central area coincident with the maximum gravity and magnetic anomalies. It is suggested that this local component is related to the highly shocked rocks of the central uplift and may have been shed from the uplift during late stage adjustments. There is no visible central topographic peak of uplifted bedrock at Haughton but studies of the post-impact Haughton Formation suggest that the center of the structure subsided 300-350 m soon after formation. Breccia studies also indicate the occurrence of shock-melted sediments, including shales, but no evidence of shock melted carbonates, the most common target lithology. This may be ascribed to the ease with which carbonates are volatilized by relatively moderate shock levels. The large amount of volatiles released on impact helped disperse the highly shocked products leading to the formation of a relatively cool clastic and polymict breccia deposit in the interior, as opposed to a coherent melt sheet. In this regard, the breccia deposit is somewhat analogous to the suevite deposits within the Ries crater. Sedimentological studies indicate that the Cretaceous-age Eureka Sound Formation was present at the time of impact and that the Haughton area has undergone as much as 200 m of erosion since the time of impact.

3319 HAJNAL, Z., SCOTT, D., POHL, J., and ROBERTSON, P.B. (1985)

First results of multidisciplinary analysis of the Haughton impact crater, Devon Island, Canada. V. Seismic studies; Abstract in, Proc. XVI Lunar and Planetary Science Sym., Houston, Texas, pp. 312-313.

Haughton has the potential to become a datum for terrestrial ring impact structures in sedimentary rocks. It is young (20±5 m.y.) and therefore well preserved. It is also well exposed because of the lack of masking soils and vegetation in its Arctic setting, so the surface geology has been mapped in detail. There is little subsurface data available for this remote region, however, and the climate and permafrost terrain place limitations on drilling and geophysical surveys that could improve the situation. In the summer of 1984 a high resolution reflection seismic profile was surveyed across the northwestern flank of the impact structure to establish the subsurface extension of roughly circular, surface structural elements, and to provide a basis for interpretation of earlier gravity and magnetic surveys.

3320 HARRISON, J.C., GOODBODY, Q.H., and CHRISTIE, R.L. (1985)

Stratigraphic and structural studies on Melville Island, District of Franklin, in Current Research, Part A, Geol. Surv. Can., Paper 85-1A, pp. 629-637.

Melville Island is a key area in the Arctic Islands for understanding the Middle to Upper Devonian clastic wedge, the Ellesmerian Orogeny, the Melvillian Disturbance, and the evolution of Carboniferous to Tertiary tectonics and sedimentation of the Sverdrup Basin margin.

A mapping project to produce new 1:250 000 scale maps and cross-sections of Melville Island was begun in 1984, and some preliminary stratigraphic and structural results are presented in this paper. Various refinements to the stratigraphy proposed by Embry, Nassichuk, Kerr and others were found to be useful in the current studies. Middle Devonian shales have acted as a regionally significant décollement horizon during the Upper Devonian Ellesmerian Orogeny; we also suggest that the Permian Melvillian Disturbance, previously interpreted as a mild orogenic pulse on northwestern Melville Island, was a period during which drape folding and extensional tectonics related to the development of the margin of Sverdrup Basin occurred.

3321 HARRISON, J.C., RIEDIGER, C.L., and BRENT, T. (1988)

Late Palcozoic extension and associated sedimentation at the southern margin of the Sverdrup Basin, Canadian Arctic Islands; Abstract in, Proc. GAC, MAC, CSPG Joint Annual Meeting, May 23-25, 1988, St. John's, Newfoundland, Program with Abstracts, Vol. 13, p. A53.

A partially exhumed, down-to-the-craton half-graben, and other extensional structures at the southern margin of the Sverdrup Basin, have been interpreted with the aid of structural and sedimentological field data, and several high quality, industry-acquired reflection seismic lines. The period of syntectonic sedimentation spanned much of the embryonic phase of Sverdrup Baffin evolution, and was represented by various alluvial fan, marginal marine, and shallow marine deposits of Late Carboniferous to Late Permian age. Asymmetric depositional patterns that characterize graben fill were influenced by synchronous reverse drag on mappable master listric faults that, locally, flatten southward into lower Palcozoic strata. However, active fault scarp erosion is only apparent in the older (Upper Carboniferous), initial basin-fill deposits. Facies patterns in the half-graben setting were also affected by a basin-wide, second-order sea level low stand, marine transgression and high stand reflecting the changing (generally decreasing) rate of differential uplift and subsidence through time.

After taking into account a mild superimposed deformation, it becomes apparent that some down-to-the-craton master listric faults sole out into an Ordovician evaporite formation which also represents the basal decoupling level in the thin-skinned deformed region of the peneplaned Parry Islands Fold Belt (latest Devonian to earliest Carboniferous) south of the Sverdrup Basin. Although extension of the craton is implied by half-graben formation, we believe that craton-directed extensional slip is matched at depth by basin-directed back-faulting on pre-existing basinward-dipping thrust faults.

3322 HARRY, D.G., FRENCH, H.M., and POLLARD, W.H. (1985)

Ice wedges and permafrost conditions near King Point, Beaufort Sea coast, Yukon Territory; in Current Research, Part A, Geol. Surv. Can., Paper 85-1A, pp. 111-116.

Observations of ice wedges near King Point, Yukon Territory, permit inferences to be made regarding their growth, contribution to ground ice volume, and use as indicators of recent climatic change. At this site, ice wedges underlie 18-20% of terrain and account for up to 21% of the total ground ice volume of the upper 5 m of permafrost. Both modern and buried, fossil ice wedges are recognized. Identification of fresh veinlets within the frozen active layer suggests that 38% of modern wedges cracked during the winter of 1983-84. More than half of the wedges examined possess one or more growth stages superimposed upon the primary wedge. The permafrost aggradation responsible for this rejuvenation provides further evidence of recent climatic cooling in the western Arctic.

3323 HARRY, D.G. (1985)

Ground ice slumps, Beaufort Sea coast, Yukon Territory; Abstract in 14th Arctic Workshop, Arctic Land-sea interaction, Nov. 6-8, Dartmouth, N.S., pp. 115-117.

Ground ice slumps represent a major erosional landform, unique to permafrost environments. They are widely distributed along the Beaufort Sea coastline of the Yukon Territory, where they are associated with high rates of coastal recession. Defined genetically as retrogressive thaw flow slides, these thermokarst features occur where massive ice or ice-rich sediments have been exposed by mass wasting or erosion. Many slumps appear to be polycyclic, with periods of rapid development and enlargement separated by intervals of relative quiescence. The nature of the triggering mechanisms which result in slump reactivation remains poorly understood, however, they may involve a combination of both thermal and mechanical energy inputs into the system. In this regard, recent proposals to construct shore-based facilities for offshore hydrocarbon exploration and production provide a strong incentive for continued study of ground ice slumps.

3324 HARRY, D.G., and FRENCH, H.M. (1988)

Cryostratigraphic studies of permafrost, northwestern Canada; in Proc. Fifth International Conf. on Permafrost, August 2-5, 1988, Trondheim, Norway, pp. 784-789.

The cryostratigraphic approach to permafrost geology emphasizes ground ice, and the dynamics of its aggradation and degradation, as an integral component of the geological record. In particular, stratigraphic evidence of paleothermal and paleohydrological conditions may be used to infer both local and regional permafrost history. Cycles of environmental change may be marked by the presence of thaw unconformities. These frequently form sharp boundaries between stratigraphic zones possessing contrasting cryotextures and may also truncate pre-existing ice structures providing evidence of partial permafrost degradation followed by the regrowth of frozen ground. Studies undertaken at four sites in northwestern Canada illustrate the principles of cryostratigraphy in relation to specific problems in permafrost geology.

3325 HARRY, D.G., FRENCH, H.M., and POLLARD, W.H. (1985)

Ice wedges and permafrost conditions near King Point, Beaufort Sea Coast, Yukon Territory; in Current Research, Part A, Geol. Surv. Can., Paper 85-1A, pp. 111-116.

Observations of ice wedges near King Point, Yukon Territory, permit inferences to be made regarding their growth, contribution to ground ice volume, and use as indicators of recent climatic change. At this site, ice wedges underlie 18-20% of terrain and account for up to 21% of the total ground ice volume of the upper 5 m of permafrost. Both modern and buried, fossil ice wedges are recognized. Identification of fresh veinlets within the frozen active layer suggests that 38% of modern wedges cracked during the winter of 1983-84. More than half of the wedges examined possess one or more growth stages superimposed upon the primary wedge. The permafrost aggradation responsible for this rejuvenation provides further evidence of recent climatic cooling in the western Arctic.

3326 HEGINBOTTOM, J.A. (1988)

A Ground Ice Map of Northwestern Canada; in Proc. Fifth International Conf. on Permafrost, August 2-5, 1988, Trondheim, Norway, Poster Presentation A2.5.

A new permafrost map of northwestern Canada, emphasizing ground ice conditions is presented. The map, at a scale of 1:1 000 000, covers the Yukon, the lower Mackenzie Valley and Delta area, and the Tuktoyaktuk Coastlands area of the western Arctic. The map was compiled from existing maps of surficial geology and terrain conditions, supplemented by site-specific observations. The extent of permafrost within each map unit is classified in a 6-step scale, from continuous (1 class), through discontinuous (4 classes) to absent (1 class). Ground ice content is classified in a 8-set scale, from high, through moderate and low, to nil, with intergrades and a variable class. The form in which the ground ice occurs is described in the legend, along with pertinent information on its geological and geomorphological setting. Known locations of selected geocryological features, such as pingos, rock glaciers and ice-cored moraines are shown by symbols. The gross distribution of permafrost and ground ice in this region is controlled by latitude, elevation, distance from the Pacific and Arctic Oceans, the seasonal positions of major air masses and glacial history. On a more local scale, geological, geomorphological, topographic and vegetational controls are more significant. In all areas, human activity can no longer be ignored as a factor influencing permafrost stability.

3327 HEGINBOTTOM, J.A., and HARRY, D.G. (1988)

Ground Ice Regions of North America; in Proc. Fifth International Conf. on Permafrost, August 2-5, 1988, Trondheim, Norway, Poster Presentation A2.4.

Six major ground ice regions are recognized within the permafrost zones of North America. They are distinguished on the basis of the form of occurrence and extent of ground ice. The regions have distinctive suites of bedrock geology, Quaternary history, surficial geology, hydrogeology and climatic history.

3213 HEGINBOTTOM, J.A., and SINCLAIR, M.P. (1985)

Cumulative Index to Permafrost Conference Proceedings (1958-1983); Geol. Surv. Can., Open File Report 1135, 215 p.

3328 HEGINBOTTOM, J.A., and VINCENT, J-S. (1986)

Correlation of Quaternary deposits and events around the margin of the Beaufort Sea: Contributions from a joint Canadian-American workshop, April 1984; Geol. Surv. Can., Open File Report 1237, 60 p.

A first approximation of a detailed correlation chart of Quaternary sediments for the Alaskan and Canadian sectors of the area adjacent to the Beaufort Sea has been compiled. The chart and contributions cover deposits and events ranging from Late Tertiary to Holocene in age. The region covered extends from the western Canadian Arctic Islands, across the Arctic Coastal Plain of Canada and Alaska and south into the Brooks Range and the mountains and basins of Yukon.

3329 HENDERSON, J.R., LeCHEMINANT, A.N., JEFFERSON, C.W., COE, K., and HENDERSON, M.N. (1986)

Preliminary account of the geology around Wager Bay, District of Keewatin; in Current Research, Part A, Geol. Surv. Can., Paper 86-1A, pp. 159-176.

In the northern coastal area of Wager Bay, banded orthogneiss and amphibolite grade supracrustal rocks of Archean or Early Proterozoic age are multiply deformed, attenuated and intruded by Early Proterozoic calc-alkaline I-type plutons which were subsequently weakly deformed. In the southern, east-trending part of Wager Bay, the same rock types are mylonitized in a zone at least 25 km wide.

Preliminary results of the mapping are presented here in three parts: (1) Megacrystic granite and granodiorite, Ford Lake; (2) Geology north of the Wager Bay Shear Zone; (3) Geology of the Wager Bay Shear Zone.

3330 HICKEY, L.J., JOHNSON, K.R., and DAWSON, M.R. (1988)

The Stratigraphy, Sedimentology, and Fossils of the Haughton Formation: A Post-Impact Crater-Fill, Devon Island, N.W.T., Canada; Meteoritics, Vol. 23, No. 3, pp. 221-231.

After the impact that formed Haughton crater, 22.4 ± 1.4 Ma ago (early Miocene), the cavity filled with water and began to accumulate lacustrine sediments. These preserve detailed evidence of pre-impact stratigraphy and post-impact morphology and development of the crater, as well as of the climatic and biotic regime in which it lay. In this report we formally designate these sediments as the Haughton Formation, of which only a 48 m thick remnant covering approximately 7 km^2 still exists. Dolomite-rich, poorly-sorted silt, fine sand, and mud are the principal lithologies. The formation unconformably overlies a blanket of allochthonous impact breccia forming the floor of the original crater. Presence of a debris-flow deposit in the base of the sequence indicates that lacustrine deposition began very shortly after crater formation.

The Haughton Formation contains a moderately diverse and highly endemic vertebrate fauna as well as palynomorphs and plant macrofossils that indicate a cool-temperate climatic regime. A small percentage of reworked Late Cretaceous and early Tertiary palynomorphs point to the former existence of the Eureka Sound Formation in the drainage area of the crater. In addition, the distribution of the lake beds indicates the absence of an inner ring on the west side of the crater, and the 3° to 3.5° inward dip of Haughton strata implies that the central mass has subsided approximately 300 to 350 m since deposition began.

3331 HILL, P.R. (1987)

Beaufort Sea coastal zone geotechnics; Geol. Surv. Can., Report of Field Activities: 1987, Open File 1902, 81 p.

During the summer of 1987, a large group of field programs was carried out under the Geological Survey of Canada's Beaufort Sea Coastal Zone Geotechnics Project. These programs were supported by the Northern Oil and Gas Action Plan (NOGAP, Project D.1). This report is a compendium of seven individual reports on the field programs carried out.

3332 HILL, P.R., and BLASCO, S.M. (1986)

Implications of a Beaufort Shelf relative sea-level curve to Arctic Mid and Late Wisconsinan Glacial events; in Correlation of Quaternary deposits and events around the margin of the Beaufort Sea: Contributions from a joint Canadian-American workshop, April 1984; Geol. Surv. Can., Open File Report 1237, pp. 55-56.

3333 HILL, P.R., FORBES, D.L., DALLIMORE, S.R., and MORGAN, P. (1986)

Shoreface development in the Canadian Beaufort Sea; in Proc. Sym. on cohesive soils, May 5-7, 1986, Burlington, Ontario, Assoc. Committee for Research on shoreline erosion and sedimentation, Nat. Res. Council, pp. 428-448.

Shoreface development in the Beaufort Sea is related to low ground temperatures and high sediment supply. Large quantities of ground-ice control erosion processes which lead to high rates of coastal retreat (up to 29 m/a). Seismic surveys and borehole analysis have shown that shoreface development is distinctly different at King Point and North Head. At King Point, a Holocene gravel barrier beach overlies Pleistocene clay and diamicton. The nearshore zone exhibits an erosive profile with no permanent accumulation of Holocene sediments between 5 and 10 m water depth. In contrast, at North Head, up to 20 m of Holocene silt and clay have accumulated in the nearshore zone in present water depths as shallow as 2 m. This sequence overlies sand and freshwater silts of late Pleistocene and early Holocene age. The differences between these two sites are being investigated by field measurements of nearshore wave climate and sediment transport processes.

3334 HILL, P.R., HEQUETTE, A., and JENNER, K.A. (1988)

Marine geology of the Canadian Beaufort Inner Shelf and Coastal Zone; Abstract in, Proc. GAC, MAC, CSPG Joint Annual Meeting, May 23-25, 1988, St. John's, Newfoundland, Program with Abstracts, Vol. 13, p. A56.

The Beaufort Shelf has undergone marine transgression during the Holocene. The thickness and lithology of Holocene sediments on the inner shelf varies according to sediment supply, pre-Holocene topography and sedimentary processes (primarily by waves and currents). Sediment supply is dominated by the Mackenzie River which supplies largely silt and clay and which has constructed a large multi-distributary delta. The silt and clay is transported eastward and forms thick inner shelf deposits seaward of the Mackenzie Delta and Richards Island, and in Kugmallit Bay. Sand and gravel are supplied primarily by erosion of low-lying Pleistocene cliffs along the Yukon coast and to the north and east of the Mackenzie Delta. The Yukon sector of the inner shelf is sediment starved and consists of an erosive platform. East of the Mackenzie Delta, sandy coastal deposits and landforms are common. Off Richards Island, transgressive silts and clays overly sandy coastal sediments, while off the Tuktoyaktuk Peninsula, the inner shelf is predominantly sandy and Holocene accumulation is relatively thin. The Mackenzie Trough and two large late Wisconsinan

outwash valleys have been filled with fine-grained sediment during transgression; Holocene sediment thicknesses in these areas exceed 20 m. The Beaufort Shelf is storm-dominated and wave energy generally increases from west to east. In areas of fine-grained sediments, large storm waves cause massive resuspension and subsequent redeposition of sediments.

3335 HILL, P.R., MUDIE, P.J., MORAN, K., and BLASCO, S.M. (1985)

A sea-level curve for the Canadian Beaufort Shelf; Can. J. Earth Sci., Vol. 22, pp. 1383-1393.

Radiocarbon-dated peat and peaty clay samples from geotechnical boreholes in the Canadian Beaufort continental shelf have been used to reconstruct a late Quaternary relative sea-level (RSL) curve. The samples were carefully selected and evaluated using palynological techniques, to ensure that reasonable age error limits could be given to each sample. The dated samples were then related to the local geological setting, using seismic profiles to determine the environment of the deposition. The resulting data show a rise of 140 m in RSL since 27 000 years BP. A minor lowering of RSL at some time between 20 000 and 10 000 years BP is inferred from acoustic data. Contributions from basin subsidence, sediment loading, and consolidation account for 35 m of the total RSL rise. The RSL curve is interpreted in the light of recent models of the isostatic and eustatic responses of the Earth's crust at the Laurentide ice-sheet margin. Ice may have been more extensive during the middle Wisconsinan than previously thought and may have caused the major lowering of sea level in the shelf area. This ice may have advanced to within several hundred kilometres of the Mackenzie Delta - Tuktoyaktuk Peninsula coast. An ice readvance of late Wisconsinan age probably caused a subsequent minor lowering of RSL.

3336 HODGSON, D.A. (1985)

Extent of terrestrial and marine ice sheets in the western Queen Elizabeth Islands; Abstract in 14th Arctic Workshop, Arctic Land-sea interaction, Nov. 6-8, 1985, Dartmouth, N.S., pp. 228-229.

Continental glaciers overran or impinged on western Queen Elizabeth Islands several times during the Quaternary. The sparse glacial landforms and deposits also record ice caps centred within the islands. During the Late Pleistocene the Viscount Melville Sound Ice Shelf extended from a grounded continental ice margin across Parry Channel, whereas between the islands, locally generated shelves possibly occurred.

3337 HODGSON, D.A. (1985)

The last glaciation of west-central Ellesmere Island, Arctic Archipelago, Canada; Can. J. Earth Sci., Vol. 22, No. 3, pp. 347-368.

Locally abundant ice-marginal landforms lie in a 500 km long zone with a distal margin 10-60 km west of the margins of modern ice caps on central Ellesmere Island. Much of this drift belt, at the heads of the fiords, was deposited by the oscillating margin of a coalesced predecessor of the modern ice caps between 9000 and 7000 BP. The ice continued to retreat east of the present margin, and readvanced to its modern limit in a middle and late Holocene cooler climate. Unweathered but undated till and striations at the base of the drift suggest that the belt does not mark the western limit of central Ellesmere Island ice in the last glaciation. The limit lies an unknown distance downfiord; glaciers in the fiords may have floated. No reliable evidence was found for a complete ice cover of western Ellesmere Island and Eureka Sound in the last glaciation; nevertheless much of central and southern Ellesmere Island and Devon Island may have been glaciated by a regime that left few erosional or depositional landforms. Alternatively, emergence of an unglaciated Eureka Sound, underway by 9000 BP, may have followed combined peripheral glacioisostatic depression by encircling ice caps, whereas the drift belt emergence was less and later, controlled only by central Ellesmere Island ice.

3338 HORIGUCHI, K. (1985)

Electric Conductivity of an Ice Core Obtained from Massive Ground Ice; in Characteristics of the Massive Ground Ice Body in the Western Canadian Arctic Related to Paleoclimatology, 1984-1985, ed. K. Fujino, Inst. Low Temp. Sci., Hokkaido Univ., Japan, pp. 37-45.

Various kinds of ground features such as polygon, pingo and massive ground ice body are commonly observed in the arctic area, especially around Mackenzie Delta, N.W.T., Canada. As for the massive ground ice body, the origins and the mechanisms of formation still remain arguable.

From data of a massive ground ice body obtained during the research expedition of 1982, we observed distinctive spikelike projections in a profile of electric conductivity of an ice core against depth. The electric conductivity is mainly determined by free ions in a specimen. Some portions of the massive ground ice body have a small amount of sediment, and other portions have a look of relatively pure ice. Massive ground ice bodies are commonly observed in the coastal region. Then if the distribution of free ions does not depend upon the existence of sediment, there is a possibility that they originated in sea water and deposited on the surface of the ground ice body when it was formed.

Therefore, in order to clarify the local portion where free ions exist, the electric conductivity of a massive ground ice body was investigated in detail. And also the specific surface area and morphology of the sediment were determined by a method using the differential scanning calorimeter (DSC) and the scanning electron microscope (SEM), respectively.

3339 HORIGUCHI, K. (1988)

Electric Conductivity of an ice Core obtained from Massive Ground Ice; in Proc. Fifth International Conf. on Permafrost, August 2-5, 1988, Trondheim, Norway, Poster Presentation A3.6.

3340 HORVATH, V., and GILBERT, R. (1985)

Sedimentation in Cambridge Fiord, Baffin Island, N.W.T., Canada; Abstract in 14th Arctic Workshop, Arctic Land-Sea Interaction, Nov. 6-8, 1985, Dartmouth, N.S., pp. 196-199.

Analysis of the physical sedimentology and paleomagnetic stratigraphy of a series of six piston cores recovered during SAFE 1982 and 1983 provides information on the sedimentary environments of Cambridge fiord. The fiord is located on the northeastern coast of Baffin Island. It is 60.8 km long with surface area of 219 km^2 and a maximum depth of 708 m. The basin is subdivided by three sills at depths of 106 m, 230 m and 330 m. The fiord received inflow from a comparatively large, 1992 km^2, drainage basin of which 240 km^2 (12.1%) is ice covered.

Three distinct sedimentary processes can be recognized from the core materials: (1) deposition of fine-grained flocculated sediment out of suspension; (2) gravitational mass flow deposits comprised of sand layers of varying thicknesses; and (3) ice rafted and dropped sediments.

3341 IOANNIDES, N.S. (1986)

Dinoflagellate cysts from Upper Cretaceous-Lower Tertiary sections, Bylot and Devon Islands, Arctic Archipelago; Geol. Surv. Can., Bull. 371, 99 p.

Diverse dinoflagellate assemblages have been recovered from Upper Cretaceous and Lower Tertiary sediments on Bylot and Devon islands, Arctic Canada. The section studied consists of the Santonian-Maastrichtian Kanguk Formation and the Lower Paleocene Eureka Sound Formation. Distinctive palynological associations have been recognized for these formations, but it is difficult to make detailed comparisons with other assemblages because of extensive reworking. Most of the species recorded are described, including two that are regarded as new (Laciniadinium williamsii sp. nov. and Palaeocystodinium bulliformum sp. nov.). A full interpretation of the structure of Thalassiphora pelagica is presented. In addition, analyses of dinocyst variability suggest that species presently attributed to different genera may represent end members of a gradational morphological complex.

3342 JACKSON, G.D. (1986)

Notes on the Proterozoic Thule Group, northern Baffin Bay; in Current Research, Part A, Geol. Surv. Can., Paper 86-1A, pp. 541-552.

Tide-dominated shelf sedimentation prevailed during deposition of that part of the Wolstenholme Formation seen by the writer, and was interrupted twice by meandering stream sedimentation and once by plateau basalt volcanism. Prodelta-type sediments occur locally at two stratigraphic positions. Part of the Dundas Formation was deposited in a subtidal restricted basin while the overlying Narssârssuk Formation contains coastal sabkha deposits. Abrupt changes in lithologies and environments may be due to syndepositional faulting.

Easterly sedimentary transport prevailed in southeast Ellesmere Island and southwesterly transport prevailed in western Greenland. A nearby land source probably lay immediately west of the Thule Group on Ellesmere Island.

The Thule Group and Bylot Supergroup were probably deposited, at least in part, as a continuous deposit in a single basin during opening of the Poseidon Ocean at 1200-1250 Ma.

3343 JACKSON, G.D., and IANNELLI, T.R. (1981)

Rift-related cyclic sedimentation in the Neohelikian Borden Basin, northern Baffin Island; in Proterozoic Basins of Canada, ed. F.H.A. Campbell, Geol. Surv. Can., Paper 81-10, pp. 269-302.

Mid-Proterozoic sedimentation in the Borden Basin began as 1000 m of braided fluvial to marginal marine quartz arenites and plateau basalts accumulated over a local regolith developed on a peneplaned gneiss complex. Deposition was initially restricted to a narrow fault-controlled channel that merged northwestward into an alluvial braidplain. The overlying 1100 m of strata were deposited during major faulting in large sandstone-shale, marine-influenced delta fan complexes that grade laterally northward into subtidal shales.

Subordinate faulting continued during deposition of the succeeding 1700 m of supratidal to shallow subtidal stromatolitic shelf carbonates that include a subtidal shale zone, and contain economic lead-zinc deposits and many gypsiferous coastal sabkha cycles.

Major faulting accompanied by local erosion and karsting occurred as about 1000 m of interbedded sandstones, shales, carbonates and boulder conglo-

merates accumulated in alluvial fan to subtidal environments. The uppermost 1200 m of strata were deposited during a relatively stable tectonic interval. Fluvial to intertidal sandstones grade upward into shallow subtidal shelf quartz arenites, and are overlain disconformably by lower Paleozoic strata.

Borden Basin was initiated as a Neohelikian aulacogen in the North Baffin Rift Zone. The Borden is one of several similar, penecontemporaneous, temporarily interconnected, basins which developed by rifting along the northwest edge of the Canadian-Greenlandic Shield. The basins are probably related to the 1200-1250 Ma old opening of the Proto-Arctic Ocean - the Poseidon Ocean.

3344 JACKSON, G.D., IANNELLI, T.R., KNIGHT, R.D., and LEBEL, D. (1985)

Neohelikian Bylot Supergroup of Borden Rift Basin, northwestern Baffin Island, District of Franklin, in Current Research, Part A, Geol. Surv. Can., Paper 85-1A, pp. 639-649.

About 6100 m of sandstones, shales, conglomerates and stromatolitic carbonates were deposited during a 1200-1250 Ma Mackenzie rifting episode and are separated into three groups: a lower and an upper sequence, each of which grades from predominantly alluvial up into basinal and/or subtidal strata, and a middle shelf carbonate sequence. Thick coastal sabkha evaporites occur in the middle carbonates, and tholeiitic subaerial basalts occur near the base of the lower group.

Episodic syndepositional faulting in northern Borden Basin was coincidental with, but less intense than that in southern Borden Basin. An uplifted western source area existed during lower Elwin and a northern source area during upper Elwin sedimentation. Some separation of Greenland from North America probably occurred during Bylot Supergroup sedimentation.

Postdepositional faulting increases in intensity northward and may be related largely to formation of Lancaster Aulacogen in the Cretaceous.

2990 JACKSON, H.R., MUDIE, P.J., and BLASCO, S.M. (1985)

Initial geological report on CESAR - the Canadian Expedition to study the Alpha Ridge, Arctic Ocean; Geol. Surv. Can., Paper No. 84-22, 177 p.

2991 JACKSON, H.R. (1985)

Knowledge of the Alpha Ridge prior to CESAR; in Geol. Surv. Canada Paper 84-22, pp. 11-14. CESAR Contr. No. 8.

3182 JACKSON, H.R., and JOHNSON, G.L. (1986)

Summary of Arctic geophysics; J. Geodynamics, Vol. 6, pp. 245-262.

3345 JACKSON, H.R. (1988)

A seismic stratigraphy for the Polar Margin; Abstract in, Proc. GAC, MAC, CSPG Joint Annual meeting, May 23-25, 1988, St. John's, Newfoundland, Program with Abstracts, Vol. 13, p. A60.

Refraction data from the northeastern Canadian polar margin collected from the Canadian Ice Island Hobson's Choice, are described and interpreted. The data are compared to sonic logs and seismic reflection profiles to develop a seismic stratigraphy for the continental shelf north of the Sverdrup Rim. A schematic geological cross-section shows 12 km of sedimentary rocks north of the rim. The upper 4 km is predicted to be Late Cretaceous to Tertiary postrift deposits with an initial velocity of 2.1 km/s and a high gradient of 0.5/s overlying about 8 km of Mesozoic to Paleozoic synrift strata with an initial velocity of 4.4 km/s and a lower gradient. The sedimentary section is underlain with crystalline basement with a velocity of 6.1 km/s. The velocity depth profile and its interpretation of post- and synrift deposits is compared to data on the east coast of Canada and shown to be similar. The geological interpretation is examined in terms of circum Arctic geology and shown to be consistent.

3346 JACKSON, H.R., and KOPPEN, L. (1985)

The Nares Strait gravity anomaly and its implications for crustal structure; Can. J. Earth Sci., Vol. 22, pp. 1322-1328.

A negative free-air gravity anomaly is associated with Nares Strait, the waterway that separates Ellesmere Island and Greenland. Two east-west gravity profiles that cross Ellesmere Island and Nares Strait were collected. A low with values in the range of -100 to -120 mGal (-1000 to -12000 $\mu m/s^2$) was observed, and two-dimensional crustal models were created to identify the cause of the anomaly. The gravity anomaly cannot be attributed wholly to the bathymetry of the strait or to the sedimentary rocks underlying the strait. Crustal models that reproduce the anomaly have a M discontinuity that slopes under Nares Strait towards Ellesmere Island so that the crust beneath Ellesmere Island is thickened. The anomaly is similar to those associated with ancient and modern suture zones, regions of collided continental crust. Plate reconstructions suggest Nares Strait is a collisional boundary between the North American Plate (Ellesmere Island) and the Greenland Plate. The gravity anomaly supports this interpretation of Nares Strait.

3347 JACKSON, K.C., and HALLS, H.C. (1985)

The age of the North Mokka Anticline, Axel Heiberg Island, Canadian Arctic Archipelago: an application of the paleomagnetic fold-test; Bull. Can. Petroleum Geol., Vol. 33, No. 2, pp. 227-235.

A paleomagnetic fold-test of sills in the North Mokka Anticline shows that the deformation both pre- and post-dates the intrusion of diabase. The anticline is one of several in the eastern part of the Sverdrup Basin that are associated with evaporite diapirs. This Late Paleozoic - Early Tertiary sedimentary basin was deformed by the Late Cretaceous to Tertiary Eurekan Orogeny, but the extent to which the orogeny initiated and formed the diapirs has been debated. The paleomagnetic direction obtained from the anticline, 286° + 72°, is the same as that from a nearby Cretaceous lava flow. The corresponding paleopole - 180°E,61°N - is also in agreement with a Cretaceous age of intrusion. These results support the suggestion that the diapirism in the Sverdrup Basin is older than, and independent of, the Eurekan Orogeny. The asymmetric distribution of sills across the anticline may reflect a local stress-environment created by the diapir.

3348 JAGO, B.C., and MITCHELL, R.H. (1985)

Mineralogy and petrology of the Ham kimberlite, Somerset Island, Northwest Territories; Can. Mineralogist, Vol. 23, pp. 619-634.

The Ham diatreme and dyke form separate fracture-controlled post-Silurian intrusive bodies in north-central Somerset Island, Northwest Territories, and consist of hypabyssal macrocrystalline serpentine-calcite kimberlite and kimberlite breccia. Alteration of previously consolidated kimberlite by fluids that deposited serpentine + calcite resulted in the development of modified kimberlites whose magnetic signature differentiates them from the unaltered varieties. Compositional data are provided by olivine, garnet and phlogopite macrocrystals. The spinel ranges in composition from aluminous magnesian chromite to magnesian ulvöspinel-magnetite. Serpentine exhibits extensive compositional variation; lizardite - 1T is developed in serpophitic segregations and retrograde olivine replacements, whereas lizardite - 6H occurs in prograde deuteric replacement and recrystallization. Ruby xenocrysts have been observed.

3349 JEFFERSON, C.W. (1985)

Uppermost Shaler Group and its contact with the Natkusiak Basalts, Victoria Island, District of Franklin; in Current Research, Part A, Geol. Surv. Can., Paper 85-1A, pp. 103-110.

The Natkusiak Formation overlies the Shaler Group with low-angular unconformity. The uppermost unit of the Shaler Group is a distinctive quartzarenite that is restricted to the southwest sector of the Holman Island Syncline area. The quartzarenite unconformably overlies the Kilian Formation and is here proposed as the Kuujjua Formation. It is cliff-forming, conglomeratic to fine-sand-sized and contains abundant tabular and trough crossbeds. Paleocurrent data suggest local fluvial transport from the south and reworking of the sands in a shallow marine tidal environment.

The uppermost Kilian Formation is informally divided into four members which are bevelled beneath the Kuujjua Formation in the southwest sector and beneath the basalts in the northeast sector. Stratigraphic and paleocurrent data suggest that the Holman Island Syncline was the site of a gently subsiding trough which was uplifted and eroded before eruption of the Natkusiak basalts. The evaporites, sabkha limestones and dolostones of the Kilian Formation are lithologically similar to the Thundercloud Formation in Mackenzie Mountains. Evaporites and red alluvial mudstones of the Redstone River Formation, which overlies the Thundercloud, appear to have no counterparts on Victoria Island.

3350 JEFFERSON, C.W., NELSON, W.E., KIRKHAM, R.V., REEDMAN, J.H., and SCOATES, R.F.J. (1985)

Geology and copper occurrences of the Natkusiak basalts, Victoria Island, District of Franklin, in Current Research, Part A, Geol. Surv. Can., Paper 85-1A, pp. 203-214.

Copper showings occur throughout Late Proterozoic Natkusiak basalts that are here informally divided into seven regionally mappable members. The basalts unconformably overlie the Shaler Group and occupy the southwest-trending asymmetric Holman Island Syncline. Prominent northwest-trending lineaments transect the syncline but are not directly associated with facies changes, copper occurrences and most faults.

Native copper with prehnite is disseminated in vesicular flows, concentrated in veins occupying joints and fractures in massive basalt, or disseminated in quartz-prehnite veins. Several native copper occurrences are close to northeast-trending faults and lineaments. Native copper is associated with prehnite, pumpellyite, chlorite, quartz and calcite, products of sub-greenschist facies metamorphism. Chalcocite and minor bornite, tetrahedrite, chalcopyrite and pyrite occur with quartz, calcite and hematite in veins and sheeted vein systems. Economic copper concentrations have not yet been identified. Copper was probably redistributed during early burial metamorphism into porous stratigraphic and structural zones within the volcanic pile.

3351 JEFFERSON, C.W., and HAMILTON, S.M. (1987)

Structure and stratigraphy of the Paleozoic-Precambrian contact zone on White and Southampton islands, District of Keewatin; in

Current Research, Part A, Geol. Surv. Can., Paper 87-1A, pp. 451-455.

The lowermost 10 m of Paleozoic strata on White Island are very recessive-weathering, intercalated friable sands and muds that unconformably overlie Precambrian gneisses and are conformably overlain by fossiliferous limestones of the Bad Cache Rapids Group. The unconformity overlain by this sequence dips gently to the southwest, as exposed on southwesterly facing slopes. The depositional contacts are offset by westerly to southerly trending, steeply dipping faults. Some faults have normal offsets. Other faults are high-angle reverse, with movement directed east-northeasterly. One of these is exposed on a steep east-facing slope. The reverse faults are interpreted to be compressive features tied into the evolution of the Boothia-Bell Arch, and related to distal continental margin plate tectonics of post-Early Silurian age.

3352 JENNER, K., and HILL, P.R. (1988)

Sedimentary environments of a distributary mouth of the Mackenzie Delta, N.W.T.; Abstract in, Proc. GAC, MAC, CSPG, Joint Annual Meeting, May 23-25, 1988, St. John's, Newfoundland, Program with Abstracts, Vol. 13, p. A61.

Nearshore and coastal environments of a distributary mouth of the Mackenzie Delta, Northwest Territories, are presently being studied to determine the relationship between sedimentary environments and the processes governing sediment transport and deposition. Patterns of deposition over the past 35 years have been documented from aerial photographs. Two main distributary channels are responsible for transporting and depositing predominantly silt and very fine sand in the form of shallow radial bars at the channel mouths. Sediment deposition has created large subaerial mudflats which choke small distributary channels causing channel abandonment. Subsequent channel infilling results in a transition from lacustrine to fresh-water marsh environments. The resulting distributary mouth environments include: subaqueous and subaerial mudflats, middle ground bars, channel levees, abandoned channels, lakes and marshes. Sediment movement is influenced by spring break-up conditions, flood events, tributary drainage basins and storm surges. Dynamic delta processes confined to a 4-month, ice-free period, result in fluctuating suspended sediment concentrations and frequent flooding of low-lying areas. Suspended sediment concentrations substantially increase during initial flooding of the delta and during periods when the suspended load of source rivers is anomalously high. Storm surges raise water levels causing inundation and sedimentation on subaerial levees and abandoned environments. Locally-generated waves rework channel margin mudflats forming well-developed wave-ripple structures.

3353 JENNINGS, A.E. (1985)

The Late Quaternary History of a Fiord/Shelf Transect, Northeastern Baffin Island; Abstract in 14th Arctic Workshop, Arctic Land-sea interaction, Nov. 6-8, 1985, Dartmouth, N.S., pp. 164-165.

The fiords and cross-shelf troughs along the eastern coast of Baffin Island are depositional basins located adjacent to the former northeastern margin of the Laurentide Ice Sheet. The sediments in these basins are key resources for understanding glacial/ocean interactions on late Quaternary time scales. Three piston cores, collected along a transect from the outer part of Clark Fiord to the outer part of Scott Trough were studied with two main objectives: (1) to determine the sedimentary processes and responses associated with the last glacial/present interglacial transition and neoglaciation; and (2) to determine what information on the terrestrial glacial record can be gained from the study of continuous sediment records from sites close to the former ice margin. Several methods, including radiocarbon dating, rock- and paleomagnetism, textural and mineralogical composition and foraminiferal analysis, were employed to provide an "absolute" chronology for each core and to delineate sedimentologic and oceanographic changes along the transect.

3354 JESSBERGER, E.K. (1988)

^{40}Ar-^{39}Ar Dating of the Haughton Impact Structure; Meteoritics, Vol. 23, No. 3, pp. 233-234.

^{40}Ar-^{39}Ar dating of a strongly shocked vesiculated gneiss clast in a breccia from the Haughton impact structure yields an isochron age of 23.4 ± 1.0 Ma. The sample contains excess ^{40}Ar.

3355 JOHNSON, G.L., and RICH, J.E. (1986)

A 30 million year cycle in Arctic volcanism?; J. Geodynamics, Vol. 6, pp. 111-116.

Arctic perimeters volcanism has pulsed to a maximum approximately every 30 million years. This periodicity is similar to that observed on a global scale.

3356 JUDGE, A. (1986)

Permafrost distribution and the quaternary history of the Mackenzie-Beaufort Region: a geothermal perspective; in Correlation of Quaternary deposits and events around the margin of the Beaufort Sea: Contributions from a joint Canadian-American workshop, April 1984; Geol. Surv. Can., Open File Report 1237, pp. 41-45.

The base of permafrost for each of 161 exploratory wells was determined using conventional well-logs as outlined by Walker and Stuart (1976), Hnatiuk and Randall (1977), Hatlelid and Macdonald (1979), and D&S Petrophysics (1983). The values determined are strictly the base of ice-bearing permafrost as revealed by changes in the physical properties, in particular the electrical and acoustic properties. In coarse-grained sediments the base may coincide closely with the 0°C isotherm, the difference depending on depth and pore-water salinity alone. In fine-grained soils the freezing characteristics of the soil predominate and the base of ice-bearing permafrost may be up to 100 m above the 0°C isotherm with a transition layer below. The bottom of the ice-bearing sediments is actually determined by a very complex set of soil characteristics, both static and dynamic, whose relationships remain poorly understood.

3357 JUDGE, A., and JONES, I. (1988)

Mapping the distribution and properties of natural gas hydrates in Canada; in Proc. Fifth International Conf. on Permafrost, August 2-5, 1988, Trondheim, Norway, Poster Presentation B4.17.

Gas hydrates are ice-like compounds which form, under the thermodynamic conditions of low ground temperature and high pressure, from mixtures of water and certain gases such as methane. As such they form in arctic regions in close association with permafrost and in the sediments of offshore areas.

The largest body of information on the natural distribution and geological characteristics of gas hydrates is contained in two geophysical sources - seismic reflection surveys and downhole geophysical logs. Surface seismic reflection surveys are normally conducted to locate possible hydrocarbon-bearing geological structures, and geophysical tools are lowered into exploration wells to detect the presence of exploitable hydrocarbons. Using a combination of such responses as bottom simulating reflectors on seismic surveys and the characteristic high acoustic velocities and electrical resistivities on borehole surveys, the apparent presence of gas hydrates can be mapped with depth within single wells and between wells.

To date, 600 suites of well surveys from northern Canada and 100 from the east coast offshore have been examined. The emerging picture of the distribution reveals considerable regional, local, and depth variation, but the presence of gas hydrates in the north appears strongly related to areas of thick permafrost. Different parts of the north show varied frequency of occurrence, e.g., in parts of the Arctic islands over half of the wells contain gas hydrates in contrast with twenty percent or less in much of the Mackenzie Delta. The distribution is strongly related to the local geology, subsurface lithology and Quaternary geological history.

3358 KATO, K., FUJINO, K., HORIGUCHI, K., and SATO, S. (1985)

Oxygen Isotope Profile in a Massive Ice Body in Mackenzie Delta, N.W.T., Canada: Preliminary Report; in Characteristics of the Massive Ground Ice Body in the Western Canadian Arctic Related to Paleoclimatology, 1984-85; ed. K. Fujino, Inst. Low Temp. Sci., Hokkaido Univ., Japan, pp. 46-56.

Distinctive ground features such as polygons, pingos and involuted hills are commonly observed in the Arctic Regions, especially around Tuktoyaktuk, Mackenzie Delta, N.W.T., Canada. The origins of water and formation processes of them still remain in need of research.

Massive ice bodies are found underneath the ground surface. Water supply from various sources related to long- and short-term climatic changes is considered to play an important role in the formation of the massive ice body. So, stratigraphic and crystallographic studies and determinations of electric conductivity, pH, oxygen isotopes and chemical compositions have been carried out to clarify the characteristics of the massive ice body around Tuktoyaktuk.

No vertically continuous profile of oxygen isotopes in massive ice bodies had been determined. Therefore, using core samples obtained throughout a massive ice body around Tuktoyaktuk, their oxygen isotopic compositions were determined to study the origin and formation processes of the massive ice body.

3359 KATO, K., FUJINO, K., HORIGUCHI, K., and SATO, S. (1985)

Profiles of Chemical Compositions in a Core from a Massive Ice Body in Mackenzie Delta, N.W.T., Canada: Preliminary Report; in Characteristics of the Massive Ground Ice Body in the Western Canadian Arctic Related to Paleoclimatology, 1984-85; ed. K. Fujino, Inst. Low Temp. Sci., Hokkaido Univ., Japan. pp. 57-70.

No profile of chemical compositions in massive ice bodies had been determined. Therefore, using core samples obtained throughout a massive ice body around Tuktoyaktuk, chemical analysis was made to study the origin and formation processes of massive ice.

3360 KERR, D.E. (1986)

Late Quaternary stratigraphy and depositional environments in the basin of the Richardson and Rae Rivers, N.W.T.; unpub. M.Sc. thesis, Dept. Geology, Univ. Ottawa, 249 p.

A detailed investigation of the stratigraphic sections in the basin of the Richardson and Rae

Rivers has led to a better understanding of the Late Quaternary history of deglaciation in this part of the Northwest Territories.

Regional lithostratigraphic correlation confirmed the existence of a major glacial lake which evolved through different phases prior to its transition to a postglacial sea following the easterly retreat of a lobe of the Laurentide Ice Sheet from the study area. The glaciolacustrine to marine transition is characterized by an upward-fining trend representing the proglacial lacustrine environment where sedimentation was controlled by a receding ice front, succeeded by an upward-coarsening trend corresponding to the regressive marine sequence resulting from isostatic uplift. No intermediate terrestrial phase or marine transgression is recorded, as the marine incursion was instantaneous since sealevel and the last proglacial lake level were approximately at the same elevation.

The complete sedimentary succession is composed of: a) basal and/or flow till, b) stratified subaqueous sand and gravel, c) glaciolacustrine silty clay rhythmites, d) massive marine silty clay, and e) littoral marine sand. The sudden passage from lacustrine to marine environments is reflected in the abrupt change in depositional mechanisms. Turbidity currents prevailed in the proglacial lake as inferred from thick sequences of varve-like couplets, whereas the salinity of marine waters, impeding the sedimentation of fines by heavy-density bottom flows, led to the deposition of structureless marine silty clays by flocculation.

Faunal evidence is indicative of near-normal marine conditions in the deeper parts of the sea, and brackish-water marginal marine environments in the upper part of the water mass resulting from the dilution of nearshore marine waters in an estuarine environment.

3361 KERR, D.E. (1987)

Preliminary interpretation of the stratigraphy of the marine offlap sequence in the Clifton Point area, District of Mackenzie; in Current Research, Part A, Geol. Surv. Can., Paper 87-1A, pp. 153-157.

The stratigraphic study of several river bank sections in the Clifton Point area, Northwest Territories has made it possible to reconstruct late glacial glaciomarine and postglacial marine environments of deposition. In the early stages of deglaciation when the ice front terminated in the sea, sequences of massive to well stratified diamicton, subaqueous outwash deposits, and silty clay rhythmites were deposited close to their glacial source. As the deglaciation of the coastal area took place, the sea contemporaneously invaded the isostatically depressed coastal lowlands. Regions in the vicinity of sediment laden deltaic waters experienced an important rhythmic sedimentation giving rise to marine rhythmites. Sedimentation in deeper areas of the sea, which remained relatively unaffected by high sediment input, resulted in the deposition of massive silty clay. These sediments were overlain by deltaic or beach sediments, typical of an offlap phase.

3362 KERR, D.E. (1987)

Depositional environments during a glaciolacustrine to marine transition in the Richardson and Rae River basin, N.W.T.; Can. J. Earth Sci., Vol. 24, No. 11, pp. 2130-2140.

This paper describes the principal glaciolacustrine deposits of a sequence of overlapping ice-marginal lakes known as glacial Lake Richardson and its transition to a postglacial sea following the retreat of a lobe of the Laurentide ice sheet from the Richardson and Rae River basin. The glaciolacustrine to marine transition is characterized by an upward-fining sequence of facies deposited in proglacial lacustrine environments, succeeded by an upward-coarsening trend corresponding to a regressive marine sequence. A composite stratigraphic section includes (a) basal diamicton, (b) stratified subaqueous sand and gravel, (c) glaciolacustrine silty clay rhythmites, (d) massive marine silty clay, and (e) littoral marine sands. The sudden passage from lacustrine to marine environments is reflected in the abrupt change in depositional mechanisms. Turbidity currents prevailed in the proglacial lake as inferred from thick sequences of varve-like couplets, whereas the salinity of marine waters, impeding the sedimentation of fines by density underflows, led to the deposition of massive structureless marine silty clays by flocculation.

3363 KERR, D.E., and MERCIER, A.L. (1985)

Stratigraphic evidence for the existence of a glacial lake in the Richardson and Rae River Basins, N.W.T.; in Contributions to the Geology of the Northwest Territories, Vol. 2, ed. J.A. Brophy, Indian & Northern Affairs, Yellowknife, N.W.T., EGS-1985-6, pp. 55-62.

Subglacial tunnels evidenced by eskers or esker fans were formed at the ice front where sediments flowing into the proglacial lake provided a suitable environment for subaqueous outwash deposits. A distinctive facies change in the downcurrent direction is thought to represent a progressive decrease in flow velocity. For this reason, the esker to varve transition is characterized by the following bedding structures: (a) planar and cross-bedded proximal gravels deposited near the mouth of an ice tunnel, (b) massive to bedded, poorly sorted medium to coarse sand, (c) fine sand and silt exhibiting type A and B cross-laminations and sinusoidal laminations, and (d) glaciolacustrine rhythmites consisting of sandy silt and clay couplets representing the finer fractions which were carried out into the lake by turbidity currents. Within the sedimentary succession studied, the glacial and proglacial environments are represented by an upward-fining

trend, succeeded by an upward-coarsening trend corresponding to the regressive marine sequence.

3364 KING, L. (1985)

Land-sea interactions in an Arctic marine low energy environment, northern Ellesmere Island, N.W.T., Canada; in 14th Arctic Workshop, Arctic Land-sea interaction, Nov. 6-8, 1985, Dartmouth, N.S., p. 144.

In many areas of the Canadian Arctic sequences of many prominant raised beaches are well known from aerial photographs or maps in scientific papers. These proofs of isostatic rebound are missing in many tributary fiords of Greely Fiord, northern Ellesmere Island. Borup, Hare and Otto Fiord have been investigated by means of aerial photographs and partly by own field studies. Many raised deltas can be found here and glaciers are pushing up moraines near sea-shore or even in the fiords in a marine environment.

3365 KLASSEN, R.A. (1985)

An outline of glacial history of Bylot Island, District of Franklin, N.W.T., in Quaternary Environments, Eastern Canadian Arctic, Baffin Bay and Western Greenland; ed. J.T. Andrews, Allen and Unwin, Boston, pp. 428-460.

Bylot Island occupies a position that is key to the glacial history of much of the eastern Canadian Arctic. It is situated near the northeastern margins of former continental ice sheets, and lies along and in front of marine channels that have been main pathways of ice flows outwards from Arctic regions during past glaciations. Consequently, the geologic record of glacier flow onto and around Bylot Island carries paleoclimatic implications that extend well beyond the area and links glacial events of Baffin Island-Foxe Basin with those of Arctic regions farther north.

3366 KNIGHT, R.D., JACKSON, G.D., and IANNELLI, T.R. (1985)

Neohelikian Elwin Formation, Borden Rift Basin, northwestern Baffin Island; Abstract in Geol. Assoc. Canada, Annual Meeting, London, Program with Abstracts, Vol. 10, p. 32.

The Elwin, uppermost formation of the Neohelikian Bylot Supergroup of Borden Rift Basin, northwestern Baffin Island, consists chiefly of laminated to thick bedded and massive micaceous, varicoloured sandstones, siltstones and minor shales. Sedimentary structures are abundant, the most common being crossbeds, ripple marks and desiccation and synaeresis cracks. About 1070 m of Elwin strata are preserved and have been divided into two intergradational members of similar thicknesses. Most lower Elwin strata are red or green, and occur in fining- and shallowing-upward cycles that contain several stromatolitic dolostone beds. Upper Elwin strata are relatively drab coloured, contain fewer structures, and are thicker bedded and more mature than lower Elwin strata. Quartzarenites predominate and coarsening-up cycles are common.

Lower Elwin strata accumulated in intertidal to supratidal and alluvial braidplain environments that included ephemeral tidal flat pools or lagoons. Crossbeds indicate easterly directed currents in the west, westerly directed in the east and northerly directed on central Borden Peninsula. Brodeur Peninsula and Byam Martin High may have been uplifted and Eclipse Trough was down-tilted eastward at this time. Upper Elwin strata accumulated in relatively stable intertidal to subtidal shelf environments. Northwesterly paleocurrents prevailed, however, local southerly directed paleocurrents may be a result of Devon High uplift.

Formation of Borden Basin and deposition of Bylot Supergroup is related to rifting during the Mackenzie igneous events and the opening of the Poseidon Ocean 1250-1200 Ma ago. Some separation of Greenland from North America may also have occurred at this time. Phanerozoic block faulting in Borden Basin is most abundant adjacent to the Cretaceous Lancaster Aulacogen.

3367 KOVACS, L.C., SRIVASTAVA, S.P., and JACKSON, H.R. (1986)

Results from an aeromagnetic investigation of the Nares Strait Region; in Polar Geophysics, eds. G.L. Johnson and K. Kaminuma, J. Geodynamics, Vol. 6, No. 1-4, pp. 91-110.

An analysis of published and recently collected aeromagnetics in the Nares Strait region shows that short wavelength, moderate amplitude magnetic anomalies are coincident with previously mapped Pre-cambrian Shield rocks under southeast Ellesmere Island. Similar magnetic anomalies are also observed in northwestern Greenland across Nares Strait. On Greenland the characteristic magnetic anomalies persist about 105 km beyond and northeast of the exposed Precambrian outcrops. This suggests that the Greenland Precambrian Shield structures previously shown as only occurring as far north as Inglefield Land actually extend at least 100 km further north. Correlation of the magnetic anomalies with mapped geological units suggest a 105 + -10 km left lateral displacement in the boundary between the Lower Paleozoic and Precambrian terrains across Nares Strait. This, we interpret, is due to the relative motion between Greenland and Ellesmere Island during the evolution of the Labrador Sea and Baffin Bay in the Early to Mid Tertiary.

3368 KRAWETZ, M.T., and McCANN, S.B. (1985)

Intertidal sedimentation in High Arctic fiords, east-central Ellesmere Island; Abstract in 14th Arctic Workshop, Arctic land-sea interaction, Nov. 6-8, 1985, Dartmouth, N.S., pp. 68-69.

The coast of east-central Ellesmere Island in the vicinity of latitude 70°N is characterized by long fiords, separated by bold headlands which project into Kane Basin and Smith Sound. High, steep, often vertical, glaciated, bedrock slopes are the main coastal landform, but moderately-wide, boulder-strewn tidal flats constitute the major element in the intertidal depositional environment. Since wave action is negligible, due to the very restricted fetches and short open water season, the joint effect of tidal and sea ice processes provides the main dynamic activity in the shore zone. Other key features of the area are the numerous tidewater glaciers and the variety of Quaternary deposits which occur at intervals around the coast.

3369 KRAWETZ, M.T., and McCANN, S.B. (1986)

Coastal characteristics, east-central Ellesmere Island, District of Franklin; in Current Research, Part A, Geol. Surv. Can., Paper 86-1A, pp. 749-754.

The coast of east-central Ellesmere Island is characterized by long fiords separated by bold headlands. The region is mesotidal with a semi-diurnal tidal oscillation. Wave activity is negligible due to restricted fetches and a short open water season; tidal and sea ice processes provide the principal dynamic activities in the shore zone. Coastal surveys from Baird Inlet to Copes Bay were completed, and a simplified coastal classification scheme was employed to describe backshore characteristics and to identify the occurrences of tidal flats in the intertidal zone. Three elements define the coastal expression: (1) bedrock, including Precambrian and Paleozoic exposures; (2) Quaternary deposits; and (3) tidewater glaciers. Tidal flats are found below till bluffs and moraines, fronting fiord head and fiord wall deltas, and at the heads of some embayments.

3370 KURFURST, P.J. (1986)

Geotechnical investigation of seabottom sediments, Tuktoyaktuk area, District of Mackenzie; in Current Research, Part A, Geol. Surv. Can., Paper 86-1A, pp. 775-778.

Standard drilling equipment and a seismic cone penetrometer have been used to characterize seabottom sediments. The drilling and geotechnical equipment is described and examples of typical lithological sequences and sounding records obtained are presented.

3371 LANE, L.S. (1987)

The Rapid Fault Array, Arctic Yukon, is a Foldbelt; Abstract in, Proc. Seminar on Petroleum Geology of the 1002 area, Arctic National Wildlife Refuge (ANWR) Coastal Plain, Alaska, Nov. 16-17, 1987, Anchorage, Alaska, Abstracts and Program, p. 11.

The Rapid Fault Array in the vicinity of Blow River contains no regionally important strike-slip or normal faults and is best characterized as a fold and thrust belt. Albian shales, sandstones and conglomerates are folded into north-south trending, upright, chevron-style structures. Competence contrast between the coarse and fine clastic units, requires that local thrust faults accommodate the shortening. Shallow fold plunges together with sub-vertical east-west striking extension fractures indicate components of vertical and north-south extension.

Comparison with structures on the Yukon coastal plain and on the continental shelf suggest that the structures are part of an extensive arcuate belt of folds that developed in Paleocene-Eocene time, indicating a correlation with Laramide Cordilleran structures.

The regional geometry of the fold belt suggests that right-lateral strike-slip displacement on the Porcupine - Sharp Mountain zone was transformed into shortening across the fold belt. Such a correlation has important implications for the magnitude and significance of strike-slip.

3372 LANE, L.S. (1988)

Early Tertiary deformation in the Blow River area, Arctic Yukon, Abstract in, Proc. GAC, MAC, CSPG Joint Annual Meeting, May 23-25, 1988, St. John's, Newfoundland, Program with Abstracts, Vol. 13, p. A71.

The structure of the Blow River area, formerly known as the Rapid Fault Array, in fact consists of a series of folds and contraction faults, and can be described as a fold and thrust belt. Albian shales were deformed into north-south trending, upright chevron-style structures, but interlayered coarse clastics formed structures with rounded hinges. Local thrust faults accommodated the differences in competence and fold styles.

Preliminary kinematic analysis of brittle structures is consistent with east-west shortening but is complicated by reactivation of mesoscopic structures. The projection of major regional scale faults (e.g. Blow, Kaltag and Yukon faults) into the area has not been documented from surface mapping or from industry seismic profiles recorded to 6 seconds.

The Albian stratigraphy consists of black shales interlayered with discontinuous sandstone and

conglomerate units with turbiditic textures. Present distribution suggests a minimum thickness on the order of 4 km for the Albian-succession.

The folds are apparently contiguous with a seismically-defined arcuate belt of offshore structures that involve Paleocene strata, but are overlain by a regionally prominent mid-Eocene unconformity. The deformation was essentially completed by mid-Eocene time, although some deformation has affected younger strata. The Blow River structures are tectonically linked to Early Tertiary structures in the Brooks Range, Alaska.

3373 LANE, L.S. (1988)

The Rapid Fault Array: a foldbelt in Arctic Yukon, in Current Research, Part D, Geol. Surv. Can., Paper 88-1D, pp. 95-98.

The Rapid Fault Array, in the vicinity of Blow River, Yukon, contains no regionally important strike-slip or normal faults and is best characterized as a fold and thrust belt. Albian shale, sandstone and conglomerate are folded into north trending, upright, chevron style structures. Owing to competence contrast between the coarse and fine grained clastic units, local thrust faults are required to accommodate the shortening. Shallow fold plunges, together with subvertical east striking extension fractures, indicate components of vertical and north-south extension.

Comparison with structures on the Yukon coastal plain and on the continental shelf suggest that the Rapid Fault Array is part of an extensive arcuate belt of folds that developed in Paleocene-Eocene time, indicating a correlation with Laramide Cordilleran structures.

The regional geometry of the foldbelt suggests that right-lateral strike-slip displacement on the Porcupine -Sharp Mountain zone was transformed into shortening across the fold belt. Such a correlation has important implications for the magnitude and significance of strike-slip displacement.

3374 LeCHEMINANT, A.N., RODDICK, J.C., TESSIER, A.C., and BETHUNE, K.M. (1987)

Geology and U-Pb ages of early Proterozoic calc-alkaline plutons northwest of Wager Bay, District of Keewatin; in Current Research, Part A, Geol. Surv. Can., Paper 87-1A, pp. 773-782.

A northeast-trending belt of I-type calc-alkaline plutons is well exposed in the region northwest of Wager Bay. The plutonic suite comprises large intrusions of hornblende-biotite granite/granodiorite with smaller bodies of monzodiorite, diorite and gabbro. The Ford Lake batholith is a 400 km^2 composite intrusion of coarse grained megacrystic granite/granodiorite enriched in K, Rb, Ba, Th and LREE. U-Pb zircon analyses provide precise crystallization ages of 1823 ± 3 Ma and 1826 + 4/-3 Ma for two plutons of the batholith emplaced into banded granitoid gneiss and (?)Penrhyn Group psammitic gneiss, calc-silicate and marble. The batholith probably intruded during late stages of regional metamorphism as part of a major episode of magma production within a continental magmatic arc.

3375 LENZ, A.C. (1986)

Morphological variation in Silurian Dicaelosia diversifrons and Epitomyonia, Arctic Islands, Canada: Caveat Emptor; in Proc. Les Brachiopodes, fossiles et actuels, eds. P.R. Racheboeuf et C.C. Emig, Biostratigraphie du Paléozoïque, Vol. 4, pp. 121-128.

Large numbers of specimens of Dicaelosia diversifrons and Epitomyonia sekwiensis and S. clausula from the Wenlockian and Ludlovian beds of the Cape Phillips Formation were studied morphometrically. Great variations in lobe length, lobe angle, and concavity of the brachial valve were noted in Dicaelosia. All specimens were assigned to a single species, D. diversifrons, but end members of any collection are highly similar to D. johnsoni, D. parvifrons, D. alticavata and D. verneuiliana. Epitomyonia shows a clear trend of increasing numbers of costellae up to the stratigraphic column. Lower to Middle Wenlockian collections are assigned to E. sekwiensis, while those of the Upper Wenlockian are assigned to the much more finely costellate E. clausula.

3376 LENZ, A.C., and MELCHIN, M.J. (1986)

A synrhabdosome of Saetograptus fritschi cf. linearis (Boucek) from Cornwallis Island, Arctic Canada; Can. J. Earth Sci., Vol. 23, No. 11, pp. 1854-1857.

A synrhabdosome of Saetograptus fritschi cf. linearis (Boucek) is described from mid-Ludlow strata of northwestern Cornwallis Island. The species is characterized by a sicula with a flaring aperture and dorsally projecting antivirgellar spine and by thecae with paired(?) spines or lappets.

3377 LENZ, A.C., and MELCHIN, M.J. (1987)

Silurian retiolitids from the Cape Phillips Formation, Arctic Islands, Canada; Bull. geol. Soc. Denmark, Vol. 35, pp. 161-170.

Isolated retiolitids recovered from limestone concretions in the Cape Phillips Formation include Pseudoplegmatograptus obesus obesus, Pseudoretiolites cf. decurtatus, Retiolites geinitzianus densireticulatus, Stomatograptus grandis grandis, S. grandis imperfectus, S. sp. Paraplectograptus eiseli, P. praemacilentus, P. sp. A, Plectograptus (Sokolovograptus) textor, Gothograptus eisenacki and Holoretiolites simplex.

Plectograptus? textor is assigned to Plectograptus (Sokolovograptus), the definition of Paraplectograptus is expanded to include morphs with a weak reticulum, and we show that reticular development and density is highly variable within these genera.

Retiolites may occasionally retain a partially to well developed prosicula; Stomatograptus and Pseudoplegmatograptus have a consistently well developed prosicula; and Pseudoretiolites possesses a well developed prosicula and, rarely, a metasicula. A sicula has not been seen in either Plectograptus (Sokolovograptus) or Paraplectograptus.

Surface sculpture is consistent within the subfamilies Retiolitinae and Plectograptinae, and serves to distinguish them.

Age ranges of taxa recovered in this study are as follows. Pseudoretiolites: triangulatus/magnus to turriculatus zones; Pseudoplegmatograptus turriculatus Zone; Stomatograptus spp.: spiralis to testis zones; Retiolites densireticulatus: spiralis to testis zones; Plectograptus (Sokolovograptus) textor: turriculatus to nassa zones; Paraplectograptus spp.: turriculatus to nassa zones; Gothograptus eisenacki: nassa Zone; Holoretiolites: nilssoni Zone.

3378 LENZ, A.C., and MELCHIN, M.J. (1987)

Peridermal and interthecal tissue in Silurian retiolitid graptolites: with examples from Sweden and Arctic Canada; Lethaia, Vol. 20, pp. 353-359.

Peridermal tissue, and thecal 'floors' are shown to be present in some specimens of Pseudoretiolites, Retiolites and Stomatograptus. The development of a dense reticulum and thecal hoods is also recognized as being a progressive developmental feature in Gothograptus. It is suggested that all these structures, whether internal or external, are the product of mature or old-age development. It appears questionable whether the Rhabdopleura model of rhabdosomal development adequately explains late-stage membranes and other adventitious tissues such as discussed herein.

3379 LEWKOWICZ, A.G. (1985)

Use of an ablatometer to measure short-term ablation of exposed ground ice; Can. J. Earth Sci., Vol. 22, No. 12, pp. 1767-1773.

An instrument (ablatometer) was developed to measure rates of ablation of exposed ground ice. When the ablatometer is mounted on a melting ice face and linked to a portable micrologger, a continuous record of short-term ablation is obtained.

The ablatometer was tested on the headwall of an active ground-ice slump located in southwest Banks Island, Northwest Territories. In general, it performed satisfactorily with little or no instrument-induced melt of the ice. Data for sunny days showed a strong diurnal rhythm of ground-ice ablation and considerable microscale spatial variability. Rates of ablation and their spatial variation were lower on cloudy days, illustrating the importance of solar insolation in inducing melt. Measurements beneath a debris cover following active-layer collapse suggest that ablation soon ceases and does not recommence until after the debris is removed by mud flow.

As a result of the high degree of spatial variability in energy inputs and consequently in ablation rates, results from a single ablatometer may not be representative. If two or more instruments are mounted concurrently on exposed ice, an average value of the energy used in ablation can be determined. This value can then be compared with measurements of energy fluxes such as net radiation.

3380 LEWKOWICZ, A.G. (1986)

Rate of short-term ablation of exposed ground ice, Banks Island, Northwest Territories, Canada; J. Glaciology, Vol. 32, No. 112, pp. 511-519.

Energy fluxes and resultant short-term ablation rates were measured at a ground-ice slump on southwest Banks Island. Net radiation, as a proportion of the ablation flux, is greatest on days with high incident solar radiation, whereas on overcast days, sensible- and latent-heat inputs may supply more than half the necessary energy. A multiple regression equation using net radiation and a turbulent-energy term as independent variables explains 79% of the variation in the measured ablation fluxes. Overall, at least 60% of the energy used for ablation at the slump is derived from net radiation.

3381 LEWKOWICZ, A.G. (1987)

Headwall retreat of ground-ice slumps, Banks Island, Northwest Territories; Can. J. Earth Sci., Vol. 24, No. 6, pp. 1077-1085.

The relationship between ice-face ablation and headwall retreat is described for three ground-ice slumps in the Sand Hills moraine, southwest Banks Island. Retreat exceeds ablation by a geometric factor that depends on the slope of the ice and the gradient of the surrounding terrain. Amounts of retreat predicted from ice-ablation calculations compare favourably with field measurements, except at the start of thermokarst activity in the spring or when the ground ice remains covered by debris for long periods.

Long-term headwall retreat for slumps in southern Banks Island with different orientations and ice contents can be estimated using a model based on meteorological information. The model predicts headwall recession of 11 m/a for a ground-ice slump facing south and 8.8-9.3 m/a for one facing north, with inputs of a 35° ice face, a ground

slope of 5°, and a volumetric latent heat of 270 MJ/m^3. These predictions are close to the maximum rates of retreat over a 10 year period as measured from air photographs.

3382 LEWKOWICZ, A.G. (1987)

Nature and importance of thermokarst processes, Sand Hills moraine, Banks Island, Canada; Geogr. Ann., Vol. 69A, No. 2, pp. 321-327.

The Sand Hills moraine of southwest Banks Island is extensively affected by backwearing thermokarst in the form of ground ice slumps. Most are initiated by coastal erosion, with the result that 75% of the land within 100 m of the coastline has been transgressed by slumps. The majority are polycyclic and typically less than 200 m in length. Mean headwall retreat rates are between 8.6 and 11.4 m/a, although a maximum of 15.5 m/a was recorded for one slump in 1983-84. On average, slumps are active for 12-15 years, a substantially shorter time than in the moraine belt of eastern Banks Island. Surface lowering rates due to backwearing thermokarst in a strip of land within 1 km of the coast, are estimated to be up to two orders of magnitude greater than probable denudation due to slopewash and solifluction processes.

3224 LOCAT, J., KURFURST, P., BERUBE, M-A., CHAGNON, J-Y., and GELINAS, P. (1988)

Viscosimetric properties of a Beaufort Sea sediment; Geol. Surv. Can., Open File 1708, 13 p.

3383 LONG, D.G.F. (1985)

Early evolution of a Lower Paleozoic passive margin: the lower Lower Cambrian history of the Franklinian sequence, Northeast Ellesmere Island, Arctic Canada; Abstract in, Geol. Assoc. Canada-Mineralogical Assoc. Canada, Joint Annual Meeting, Univ. New Brunswick, Fredericton, N.B., May 15-17, 1985, Program with Abstracts, Vol. 10, p. A35.

The Franklinian sequence of the Canadian Arctic Islands may have been initiated by rifting in Late Proterozoic to Early Cambrian times, but no record of this early phase of basin evolution is exposed. The oldest strata exposed belong to the Kennedy Channel Fm., which contains minor trilobite and brachiopod debris, and is consequently placed in the lower Lower Cambrian, in a pre-Olenellus trilobite zone. Strata of the Kennedy Channel Fm. reflect repeated progradation of shallow water platformal clastic and carbonate facies into deeper water environments to the NW. The conformably overlying dolomites and mudrocks of the Ella Bay Fm. reflect development and progradation of a rimmed carbonate platform. Local thickness and facies changes reflect development of basin and swell topography, which may be inherited from the initial rifting stage of the evolution of the margin. The Ella Bay Fm. is separated by a major erosional unconformity from the overlying mudstones and sandstones of the Ellesmere Group. This may represent a breakup unconformity as units above it thicken progressively towards the NW, and lap onto older strata to the SE. The Ellesmere Group reflects progressive subsidence of the continental margin as the Franklinian basin evolved. It is dominated by sandstones, which include fluvial facies to the SE and shallow to deep water storm influenced facies to the NW and mudrocks, which increase in importance to the NW and may pass laterally into basinal strata of the Grantland Fm. in the Hazen Trough.

3157 MacDONALD, G.M., and RITCHIE, J.C. (1986)

Modern pollen spectra from the western interior of Canada and the interpretation of Late Quaternary vegetation development; New Phytol., Vol. 103, pp. 245-268.

3384 MACKAY, J.R. (1985)

Permafrost growth in recently drained lakes, Western Arctic Coast; in Current Research, Part B, Geol. Surv. Can., Paper 85-1B, pp. 177-189.

A study of permafrost growth in lakes that have drained recently along the Western Arctic Coast has been carried out from 1971 to 1984. The sublake bottom sediments are mainly sands. Bench marks on the drained lake bottoms have been repeatedly surveyed and ground temperatures measured. The uplifts of the bench marks have been used to estimate the uplifts from the volume change of water to ice as permafrost aggrades beneath the drained lake bottoms. The temperature measurements have been used to estimate freezing conditions in the basal part of aggrading permafrost and apparent thermal diffusivities. The results show that: the growth rate of ice-bonded permafrost is less than that of non ice-bonded permafrost; the zone between the 0°C isotherm and the isotherm where nearly complete freezing of pore water occurs can be many metres in thickness; and the apparent thermal diffusivities give good indications as to the depths at which phase changes occur. There is field evidence to suggest that the downward movement of water in summer from the thawed active layer with freezing in the still frozen active layer and top of permafrost may contribute to lake bottom uplift. The uplift of bench marks appears to be greatest when the winter snow depth is the least.

3385 MACKAY, J.R. (1985)

Pingo ice of the western Arctic coast, Canada; Can. J. Earth Sci., Vol. 22, No. 10, pp. 1452-1464.

A field study of pingo ice exposures shows that all pingos contain pore ice and varying proportions of intrusive ice, segregated ice, dilation

crack ice, and ice wedge ice. The intrusive ice is derived from water in a subpingo water lens. The ice is usually pure and columnar grained with c axes normal to the direction of heat flow. The columnar grains tend to develop parallel lines normal to the c axis upon exposure to radiation. Precise surveys of pingo growth for the 1973-1983 period show that displacement vectors are upward and radially outward and that radial dilation cracks are produced by circumferential stretching. The dilation cracks, which can open at any time of the year, become infilled with surface water and also with soil from the pingo overburden. The cumulative width of the dilation crack ice approximates the stretch of the pingo overburden as it is domed by pingo growth. Dilation crack ice is vertically banded. The bands are much wider than those in ice wedge ice and have less vertical taper to them. Segregated ice, under high subpermafrost pore-water pressures, may grow in medium-grained sands. Calculations based upon the 1973-1983 growth of one pingo with an intrusive ice core show that the annual increment of intrusive ice is greatly exceeded by pore ice and segregation ice, an observation probably true for many pingos.

3386 MACKAY, J.R. (1986)

Fifty years (1935 to 1985) of coastal retreat west of Tuktoyaktuk, District of Mackenzie; in Current Research, Part A, Geol. Surv. Can., Paper 86-1A, pp. 727-735.

Coastal recession from 1935 to 1985 has been determined for four sites to the immediate west of Tuktoyaktuk, Northwest Territories. The 1935 shoreline position has been mapped from oblique air photographs and the positions of the shoreline from 1950 to 1985 from vertical air photographs and field studies. The mean rates of coastal retreat have been about: 8 m/year for high centre polygons underlain by a high ice content diamicton; 7 m/year for a tabular body of massive ice; 1 m/year or less for a sectioned pingo with a thick overburden of sands; and 1 m/year or less for sandy coastal bluffs. The rate of retreat is primarily a function of the amount of excess ice in the coastal bluffs and the severity of late summer storm surges. Where excess ice extends below sea level, some offshore thermokarst depressions have developed.

3387 MACKAY, J.R. (1986)

Growth of Ibyuk Pingo, Western Arctic Coast, Canada, and Some Implications for Environmental Reconstructions; Quaternary Res., Vol. 26, No. 1, pp. 68-80.

Ibyuk Pingo, which is 49 m high and 300 m in basal diameter, is one of the largest pingos in the world. Precise surveys carried out for the 1973 to 1983 period indicate that the lower half of the pingo, below a height of 25 m, shows no perceptible growth. From 25 m to the top, the growth steadily increases to a maximum of 2.3 cm/yr at the summit. The source of growth is believed to lie at a depth of about 65 m below the highest peak. Evidence based upon the depth of permafrost near the pingo, radiocarbon dating of wood in the pingo overburden, heat conduction theory, and the measured growth rate suggests an age of about 1300 ± 200 yr. Ibyuk Pingo is in an unstable state and collapse could be initiated by further slumping, a thermal disturbance to the crater, or erosion along a radial dilation crack. A study of the potential collapse pattern of Ibyuk Pingo suggests a number of criteria that might be employed in the environmental reconstruction of large circular features that might be identified as collapsed pingo remnants.

3388 MACKAY, J.R. (1986)

The first 7 years (1978-1985) of ice wedge growth, Illisarvik experimental drained lake site, western Arctic coast; Can. J. Earth Sci., Vol. 23, No. 11, pp. 1782-1795.

A large lake, measuring 600 m x 300 m and with a depth of nearly 5 m, was artificially drained on 13 August 1978. Observations on the formation, width, and depth of thermal contraction cracks for the first 7 years show that the crack profiles and ice wedge growth rates differ markedly from those of old ice wedges reported in the literature. The first winter's cracks had box-like profiles, with surface widths to 10 cm and depths to 2.5 m. Some cracks continued to widen and deepen, once opened in early winter, and then narrowed or even closed completely in summer. Mean growth rates for the ice wedges for the first few years have been as much as 3.5 cm/year. Temperature gradients at the time of first cracking have been in the range of 10-15°C/m. The growth rate of young ice wedges is site specific and temperature dependent, varying with factors such as the temperature gradient, vegetation, and snow cover, so an estimate of the age of an ice wedge from its width will usually be impossible. A study of crack widths indicates that the apparent coefficient of linear expansion of frozen ground may be several times that of ice. Upward cracking has been proven.

3389 MACKAY, J.R. (1986)

The permafrost record and Quaternary history of northwestern Canada; in Correlation of Quaternary deposits and events around the margin of the Beaufort Sea: Contributions from a joint Canadian-American workshop, April 1984; Geol. Surv. Can., Open File Report 1237, pp. 39-40.

Pre-Wisconsinan interglacial and glacial deposits have been identified in many areas of Northwestern Canada, but the direct evidence for pre-Wisconsinan permafrost, as given by ice-wedge pseudomorphs and other permafrost related features, is limited. For example, an ice-wedge pseudomorph, overlain by sediments preserving a record of three major glacial periods has been reported for

southeastern Yukon. In central Yukon, sand wedges, presumably indicative of permafrost conditions, developed beyond the limit of the Reid (Early Wisconsinan or Illinoian) Glaciation. Ice-wedge pseudomorphs along the Yukon Coast that underlie Buckland (Early Wisconsinan) till are considered to be Sangamon or of early Wisconsinan age.

3390 MACKAY, J.R. (1987)

Some mechanical aspects of pingo growth and failure, western Arctic coast, Canada; Can. J. Earth Sci., Vol. 24, No. 6, pp. 1108-1119.

Many closed-system pingos are underlain by sub-pingo water lenses, and the same is probably true of numerous open-system pingos. In the early growth stage the bending of the frozen overburden of a pingo by a sub-pingo water lens can be compared to the bending of a thin elastic plate. Although the assumptions of elastic plate theory do not apply fully to a growing pingo, because time-dependent plastic and creep deformation are involved, the application of elastic plate theory nevertheless helps to explain the peripheral normal faulting and spring flow of pingos, summit failure, the ease with which elongated pingos appear to collapse, and the changing roles played by the radius and overburden thickness of pingos from early growth to the cessation of growth.

3391 MACKAY, J.R. (1988)

Ice wedge growth in newly aggrading permafrost, western Arctic Coast, Canada; in Proc. Fifth International Conf. on Permafrost, August 2-5, 1988, Trondheim, Norway, Vol. 1, pp. 809-814.

The western Arctic coast of Canada is in an area of continuous permafrost where many lakes drain rapidly by erosion of ice wedges at their outlets. Drainage initiates permafrost aggradation in the first winter on the exposed lake bottoms. Frequently, thermal contraction cracks open in the first winter even where frozen ground is only 3 or 4 m deep. During the summer thaw period, some thermal contraction cracks become plugged near the surface with ice veins and frozen mud so that summer re-expansion of the ground seals the cracks before appreciable water can percolate downward to form ice veinlets. Some other cracks infill quickly with water to grow ice veinlets. Therefore, the annual growth rate for ice wedges is highly variable being site specific and time dependent. The ice wedge growth rate for the first few years can range from near zero to at least 2.5 cm/yr.

3392 MACKAY, J.R., and LESLIE, R.V. (1987)

A simple probe for the measurement of frost heave within frozen ground in a permafrost environment; in Current Research, Part A, Geol. Surv. Can., Paper 87-1A, pp. 37-41.

Laboratory experiments have shown that unfrozen water in a frozen soil can move under a temperature gradient from warmer to colder areas. Field experiments have demonstrated that unfrozen water in frozen ground in a permafrost environment may move upward and downward in an annual cycle, in both the frozen active layer and the top of permafrost. A simple magnet probe for the field measurement of heave within frozen ground and settlement of thawing soil is described. Results of three years of field trials at Inuvik and Illisarvik, Northwest Territories show a resolution of 1 mm and general agreement with other methods.

2993 MacLEAN, B. (1986)

CSS HUDSON Cruise 86-027; Geol. Surv. Can., Atlantic Geoscience Centre Cruise Report, 36 p.

3393 MacLEAN, B., and VILKS, G. (1986)

Marine geological program in the Byam Martin Channel-Lougheed Island region, District of Franklin; in Current Research, Part A, Geol. Surv. Can., Paper 86-1A, pp. 769-774.

A seabed sediment sampling program was carried out through the ice in the Byam Martin Channel-Cameron Island-Lougheed Island region of the Canadian Arctic Archipelago in April and May 1985.

Sampling operations were carried out at 79 stations over a 23 200 km^2 area mainly with a 27 kg gravity corer. Maximum core recovery was approximately 1 m. Grab samples were obtained at 19 stations with a Dietz-Lafonde sampler.

Preliminary results indicate that the upper metre of seabottom sediments consists predominantly of silt or clay with variable amounts of coarser material. Foraminifera in the surface sediments indicate a distinct faunal break at 200 m water depth which is related to water mass characteristics.

3394 MacLEAN B., VILKS, G., and SONNICHSEN, G. (1988)

Quaternary geology of Arctic interisland channels; Abstract in Proc. GAC, MAC, CSPG Joint Annual Meeting, May 23-25, 1988, St. John's, Newfoundland, Program with Abstracts, Vol. 13, p. A77.

Wellington, Byam Martin and Austin channels, eastern Barrow Strait, and Norwegian Bay contain widespread deposits of glacial drift, locally overlain by thin (typically 2 to 3 m) deposits of glaciomarine and postglacial sediments. Locally the drift forms positive features interpreted as moraines and in places contains multiple sequences. The glacial drift may include deposition by both local ice caps and more regionally extensive ice sheets. Regionally the surficial sediments range from a few metres to 30 metres, but thicker

deposits occur locally, e.g. to 100 m in eastern Barrow Strait.

Geotechnical, foraminiferal and textural data show consistent relationships between piston cores and with the acoustic stratigraphic units recognized from high resolution seismic profiles. The postglacial sediments have high water content, low bulk density and low shear strength; the converse applies to glaciomarine and glacial drift sediments. Foraminifera are relatively diverse in the post glacial sediments, less diverse in glaciomarine sediments, and the glacial drift is barren.

The surficial sediments lie on variably dipping sedimentary rocks which are structurally more complex in Norwegian Bay than farther west.

3395 MAMET, B.L., ROUX, A., and NASSICHUK, W.W. (1987)

Algues carbonifères et permiennes de l'arctique canadien; Commission Géologique du Canada, Bull. 342, 143 p.

Les formations carbonatées carbonifères et permiennes de l'Archipel arctique canadien ont livré une microflore bien conservée comprenant plus d'une soixantaine d'espèces appartenant à 48 genres. Cinq genres sont nouveaux: Ellesmerella n. gen. (type: E. permica (Pia)), Halimedoides n. gen (type: H. arctica n. sp.), Nansenella n. gen. (type: N. multiramosa n. sp.), Richella n. gen. (type: R. incrustata n. sp.) et Stacheoidella n. gen. (type: Stacheoides spissa Petryk et Mamet). On y ajoutera deux nouvelles espèces, Anthracoporella girtyi n. sp. et Diplopora belcherensis n. sp. Le Namurien transgressif recèle de nombreuses Donezella qui y forment des buttes carbonatées. Le Bashkirien et le Moscovien voient respectivement le développement de "boundstones" à Komia et Ungdarella, puis l'apparition des Algues phylloïdes (Eugonophyllum, Neoanchicodium, Ivanovia). Les Béréselles (Dvinella, Uraloporella) forment des "bafflestones" dès le Moscovien moyen. Le Carbonifère supérieur est peu caractéristique dans l'Arctique et il manque d'ailleurs dans plusieurs sections. L'Asselien montre de nombreuses Epimastopora, Enfin le Sakmarien voit la diminution progressive, puis la disparition des Algues phylloïdes, et leur remplacement par des Dasycladacées.

La flore est moyennement diversifiée et ce, bien moins que la microflore téthysienne. Elle indique un réchauffement progressif qui fait passer les eaux tempérées namuriennes aux eaux tempérées chaudes du Permien inférieur.

3158 MATTHEWS J.V., Jr., MOTT, R.J., and VINCENT, J-S., (1986)

Preglacial and interglacial environments of Banks Island: pollen and macrofossils from Duck Hawk Bluffs and related sites; Géographie physique et Quaternaire, Vol. XL, No. 3, pp. 279-298.

3159 MATTHEWS, J.V., Jr. (1987)

Plant macrofossils from the Neogene Beaufort Formation on Banks and Meighen islands, District of Franklin, in Current Research, Part A, Geological Survey of Canada, Paper 87-1A, p. 73-87.

3396 MAUREL, L.E., and MAYR, U. (1988)

The geometry and the origin of the Grinnell-Douro Range, NW Devon Island, Canadian Arctic Archipelago; Abstract in Proc. GAC, MAC, CSPG Joint Annual Meeting, May 23-25, 1988, St. John's, Newfoundland, Program with Abstracts, Vol. 13, p. A80.

The Grinnell-Douro Range extends for 100 km on NW Devon Island, in the eastern part of the Canadian Arctic Archipelago. It consists of a series of aligned thrust anticlines, trending N70°W and affecting Lower and Middle Paleozoic rocks of the Arctic platform. These structures are situated amidst the flat-lying or gently warped strata of Devon Island, and are oblique to the northerly trending Boothia Uplift to the west and the easterly trending folds of southern Ellesmere Island to the east.

Middle Ordovician gypsum represents the oldest exposed hanging wall rock unit and is steeply (40-70°) thrust over Lower and Middle Devonian carbonates. This evaporite layer is interpreted to be the glide horizon which favoured the propagation of the thrust. Maximum horizontal shortening does not exceed 3 km, that is 3% of the strike length of the belt.

The timing of the compressive event is latest Devonian to earliest Carboniferous. Also, the Douro Range is flanked to the NE by a series of grabens filled by Carboniferous-Permian strata. These features represent a younger extensional phase which resulted in the collapse of the anticlinal structures.

The peculiar location and trend of the thrust anticlines are thought to be related to a favourable anisotropy in the basement. Reactivation along the pre-existing fabrics may have been the driving mechanism for the development of the fold-and-thrust belt of the Grinnell-Douro Range.

3397 McCANN, S.B., and KRAWETZ, M.T. (1984)

Coastal geomorphology and sedimentology in the Arctic Islands: an investigation into the morphology and mobilization of sediments on Arctic tidal flats; Polar Cont. Shelf. Proj., internal report, 40 p.

Tidal flats occur in a wide range of tidal and wave regimes in the eastern Canadian Arctic and constitute a major unit in the coastal deposi-

tional environment. The morpho-sedimentological development of tidal flats is complicated by the presence of sea ice which represents the dominant process agent at arctic sites. In concert with the seasonal variability of sea ice breakup and the spatial variation in tidal range, sea ice processes are responsible for the formation of distinctive depositional features. Boulders produce the most pronounced morphologies, and may occur singly, strewn across the tidal flat surface, or may be arranged in mounds, ridges and barricades. These arrangements affect the subsequent sedimentological and morphological expression of the intertidal zone. It is hypothesized that the mobilization of boulders across the intertidal zone is accomplished by sliding and rolling along the bed and/or by rafting by ice floes.

The general objective of this study was to investigate the effects of sea ice on the morphology and sedimentology in the coastal zone of a high arctic situation.

3398 McCRACKEN, A.D., and LENZ, A.C. (1987)

Middle and Late Ordovician conodont faunas and biostratigraphy of graptolitic strata of the Road River Group, northern Yukon Territory; Can. J. Earth Sci., Vol. 24, pp. 643-653.

Ordovician conodont faunas from the fine-grained clastic Road River Group in northern Yukon Territory contain a mixture of species from both warm- and cold-water regions. This group in southwestern Northwest Territories also has mixed faunas, whereas conodonts from the carbonate facies are more characteristic of the warm-water regions.

Six conodont associations and biozones are identified from the Yukon. Some such as the early Llanvirn "Cordylodus" horridus - Spinodus spinatus association, contain reworked elements. The Pygodus serra Zone (middle-late Llanvirn) is within the upper P. tentaculatus Zone and well below the G. euglyphus Zone. Genera include Ansella, Periodon, Protopanderodus, Pygodus, and Walliserodus.

At Peel River, conodonts are within the P. pacificus Zone. The Blackstone River conodonts occur above the P. pacificus Zone and below the G. persculptus Zone (?) and include Oulodus rohneri, Plectodina florida, and Noixodontus. Amorphognathus ordovicicus, Gamachignathus ensifer, O. ulrichi, and Plectodina tenuis occur in both faunas. These represent Fauna 12, found in late Richmondian strata, rather than the Gamachian Fauna 13 and are assigned to the G. ensifer Zone; both occurrences of G. ensifer are biohorizons. The C.? extraordinarius and G. persculptus zones are not recognized at Peel and Rock rivers and Tetlit Creek.

The Ozarkodina n. sp. A - Icriodella sp. B association occurs at Pat Lake between the G. persculptus Zone (?) and the underlying P. pacificus Zone. The Ozarkodina have a Silurian aspect but must be regarded as Ordovician.

The Ordovician-Silurian boundary in the Road River Group of the Yukon is best defined using graptolites because of the rare occurrence of conodonts.

3399 MELCHIN, M.J., and LENZ, A.C. (1986)

Uncompressed specimens of Monograptus turriculatus (Barrande, 1850) from Cornwallis Island, Arctic Canada; Can. J. Earth Sci., Vol. 23, pp. 579-582.

Isolated specimens of Monograptus turriculatus (Barrande, 1850) have been recovered from calcite concretions of the turriculatus Zone (late Llandovery) from the Cape Phillips Formation, Canadian Arctic Islands. The sicula shows ventral as well as dextral lateral curvature, and the thecae show a pronounced lateral asymmetry. This asymmetry is manifest as a tear-shaped aperture, a long, laterally directed spine on the outer apertural margin, and a shorter, ventrally directed spine on the inner apertural margin. The latter spine is totally absent on the proximal thecae.

3400 METZLER, A., OSTERTAG, R., REDEKER, H.-J., and STÖFFLER, D. (1988)

Composition of the Crystalline Basement and Shock Metamorphism of Crystalline and Sedimentary Target Rocks at the Haughton Impact Crater, Devon Island, Canada; Meteoritics, Vol. 23, pp. 197-207.

About 100 cobble-sized samples collected from the surface of the central polymict breccia formation of Haughton impact crater, Canada, have been studied microscopically and chemically. Breccia clasts derived from the 1700 m deep Precambrian basement consist of 13 rock types which can be grouped into sillimanite- and garnet-bearing gneiss; alkali feldspar-rich aplitic or biotite-hornblende-bearing gneiss; biotite and hornblende gneiss, apatite-rich biotite and biotite-hornblende gneiss; calcite-diopside gneiss, amphibolite; tonalitic orthogneiss; and basalts. The range of chemical compositions of these rocks is wide: e.g., SiO_2 ranges from 40-85 wt.%; Al_2O_3 from 7-20 wt.%; CaO from 0.01-25 wt.%; or P_2O_5 from <0.01-5 wt.%. Nearly all samples of crystalline rocks are shock metamorphosed up to about 60 GPa. Most conspicuous is the absence of whole-rock melts and the very rare occurrence of unshocked rocks. The 45 samples examined can be classified into the following shock stages: stage 0 (<5 GPa): 4.5%, stage Ia (10-20 GPa): 9.0%, stage Ib (20-35 GPa): 33%, stage II (35-45 GPa): 29%, stage III (45-55 GPa): 18%, stage III-IV (55-60 GPa): 6.5%. Among Paleozoic sedimentary rock clasts higher degrees of shock than within crystalline rocks were observed such as highly vesiculated, whole-rock melts of sandstones and shales. Within the northern and eastern sectors of the allochthonous breccia no distinct radial variation of the cobble-sized lithic clasts regarding abundance, rock type, and degree of shock was

observed, with the exception that clasts of shock-melted sedimentary rocks and of highly shocked basement rocks (stage III-IV) are strongly concentrated near the center of the crater. Based on our field and laboratory investigations we conclude that vaporization and melting due to the Haughton impact affected the lower section of the sedimentary strata from about 900 to 1700 m depth (Eleanor River limestones and dolomites, Lower Ordovician and Cambrian limestones, dolomites, shales, and sandstones). The 60-GPa shock pressure isobar reached only the uppermost basement rocks so that whole rock melting of the crystalline rocks was not possible.

3401 MIALL, A.D. (1985)

Stratigraphic and structural predictions from a plate-tectonic model of an oblique-slip orogen: The Eureka Sound Formation (Campanian-Oligocene), northeast Canadian Arctic Islands; Soc. Economic Paleontologists and Mineralogists, Spec. Pub. 37, pp. 361-374.

A recent synthesis of Cretaceous-Cenozoic plate kinematics in the North Atlantic region by Srivastava and Tapscott (in press) provides a framework for a detailed interpretation of the geology of the northeast Canadian Arctic Islands.

The plate model indicates a pattern of successive transgression, transtension, and near-orthogonal convergence between Greenland and Ellesmere Island (northeasternmost of the Arctic Islands) during Campanian to early Oligocene time. Earlier interpretations suggested that this displacement was accommodated by a transcurrent fault along Nares Strait, the waterway dividing these land masses. The alternative model discussed here is that displacement was diffused across the Eurekan Orogen, a zone of open folds, low- to high-angle reverse faults and normal faults that marks the plate boundary. Structural analyses demonstrate 25% to 50% crustal shortening, but the location and style of lateral offset (discrete strike-slip faults, block rotation, pervasive shear, or a combination of all three) remains uncertain.

The plate model can account for the geometry, facies, and age of syn-tectonic stratigraphic units deposited across the Eurekan Orogen. Initial transpressive movements (Campanian to late Paleocene) caused the fragmentation of Sverdrup Basin into smaller depocenters and intervening, fault-bounded uplifts, from which fluvial-deltaic clastic wedges prograded. This phase ended with thrust faulting and the growth of flanking fanglomerate wedges in eastern Ellesmere Island.

Transgression and retrogression accompanied a brief episode of transtensional plate movement (late Paleocene to early Eocene). The pole of rotation of Greenland then gradually underwent a major change, and movement across the plate boundary changed to transpression and then to near orthogonal convergence. Renewed clastic progradation culminated in a major episode of fan progradation during the main phase of Eurekan folding and thrust faulting (latest Eocene to earliest Oligocene).

Eurekan tectonism and sedimentation ended when sea-floor spreading in the Labrador Sea and Baffin Bay ceased in the early Oligocene, and Greenland became coupled to North America.

3402 MIALL, A.D. (1986)

The Eureka Sound Group (Upper Cretaceous-Oligocene), Canadian Arctic Islands; Bull. Can. Petroleum Geology, Vol. 34, No. 2, pp. 240-270.

More than 18.5 km of new stratigraphic sections in central Ellesmere Island and Axel Heiberg Island form the basis for redefining the Eureka Sound Formation as a group with nine constituent formations, and include the type sections for six of the nine new formations.

Palynostratigraphic data are used to show that most of the units are markedly diachronous, reflecting a complex paleogeographic evolution of the Arctic Islands area during the various phases of the Eurekan Orogeny. Sediments were shed from active upwarps, such as Princess Margaret Arch and Sverdrup Basin Rim, into seven major basins. Sedimentation may also have been affected by regional (global?) changes in sea level. Most deposits are fluvial or deltaic, but a major marine transgression occurred in Remus Basin (central Ellesmere Island) during Late Paleocene - Early Eocene time.

3403 MICHEL, F.A. (1985)

Nature and history of ground ice in the Yukon - Isotope Investigations, Carleton Univ., Report to Energy, Mines & Resources, Earth Physics Br., 135 p.

Massive ice and ice-rich sediments from a number of sites in central and northern Yukon have been examined stratigraphically and isotopically. Within the central Yukon, ice-wedge ice, segregated ice and frost-blister ice have been identified. Along the northern Yukon coastal plain, massive ice and ice-rich sediments, exposed in the headwalls of retrogressive thaw slides, have been interpreted as ice-wedge ice, segregated ice and buried glacier ice. The buried glacier ice, probably of early Wisconsinan age, exists near King Point, Kay Point, and on Herschel Island in what have been described as ice-thrust moraines. Each ice type displays a characteristic isotopic signature which is useful in identifying the origin of the ice. Further research is required on the hydrogen isotope distribution and the ^{18}O-^{2}H relationships for each ice type.

3404 MORGAN, P. (1986)

Sediment transport study at King Point, Yukon Territory; in Current Research, Part B, Geol. Surv. Can., Paper 86-1B, pp. 859-863.

A field study was conducted at King Point to collect sediment transport and coastal zone data. Nearshore directional wave measurements were collected for the first time in the Canadian Beaufort Sea. The data also included wind speed and direction, bottom current velocities and directions, sediment samples and beach and bathymetric profiles. The data will be used to calibrate numerical models to estimate wave climate and alongshore sediment transport rates and directions.

3405 MORRIS, T.H., CLARK, D.L., and BLASCO, S.M. (1985)

Sediments of the Lomonosov Ridge and Makarov Basin: A Pleistocene stratigraphy for the North Pole; Geol. Soc. America Bull., Vol. 96, pp. 901-910.

Sediments of 16 short cores taken as part of the Lomonosov Ridge Experiment (LOREX) can be organized into the first Pleistocene stratigraphy for the North Polar region. This stratigraphy can be correlated with stratigraphic units described from the Alpha-Chukchi areas, ~300 km distant.

The LOREX cores include at least 12 sedimentary subunits differentiated by texture, color, and carbonate content. The units are silty and arenaceous lutites and are principally glacial-marine. Benthic and planktonic foraminifera, degree of bioturbation, and Fe-Mn micro-nodule abundance generally are positively correlated. Foraminifera in core B-8, from 3,956 m in the Makarov Basin, may have been affected by CCD fluctuations that did not affect fossils in core B-24, from 1,600 m on the crest of the Lomonosov Ridge.

The 12 stratigraphic units were deposited during the late Pleistocene and represent the same major sedimentary events as those of stratigraphic units K, L, and M of the Amerasian Basin. This correlation is excellent evidence for the remarkable and widespread uniform depositional style of glacial-marine sediment. Times of major glacial ice transport reflect deglaciation events in the central Arctic Ocean. Surface currents during deglaciation transport glacial ice in a more or less uniform pattern over at least 50% of the Arctic Ocean. Even thin sedimentary units deposited during relatively long time intervals are correlated over >500,000 km^2.

3406 MORROW, D.W., and KERR, J.W. (1986)

Geology of Grinnell Peninsula and the Prince Alfred Bay area, Devon Island, District of Franklin, N.W.T.; Geol. Surv. Can., Open File 1325, GSC List 951, 45 p.

3407 MUDIE, P.J., HEIN, F.J., and VAN WAGONER, N.A. (1988)

Marine geology studies of sediments on the Canadian Polar Margin; Abstract in Proc. GAC, MAC, CSPG Joint Annual Meeting, May 23-25, 1988, St. John's, Newfoundland, Program with Abstracts, Vol. 13, p. A88.

Perennial pack and shelf ice cover the continental shelves from Axel Heiberg to Ellesmere Island - the coldest part of the Arctic Ocean margin. The Canadian Ice Island enabled collection of the first sediment samples and cores from the region, using i) a 40 m deep hydrohole melted through the Ice Island; ii) a portable coring system deployed from the sea ice on helicopter flights across Axel Heiberg shelf. Echosounder and 3.5 kHz profiles and bottom photographs were also obtained. Studies of lithology, mineralogy, magnetic susceptibility and micropaleontology show that five late Quaternary sediment units (A-E) are widely correlatable over depths of 120-300 m on the inner shelf. The outer shelf and upper slope at depths of 400-1200 m have a veneer of the postglacial Holocene unit A overlying massive interbedded gravelly and sandy muds of probable Late Wisconsinan age. Lithofacies primarily reflect climate controlled fluctuations in the extent of ice shelves and valley glaciers entering a full glacial ocean; there is no evidence for major ice sheet or ice cap expansion over the shelf. Synsedimentary fault structures in cores adjacent to a bedrock ridge, however, may indicate either isostatic adjustment to unloading of continental ice or tectonism on this unusually deep continental shelf.

3183 MUDIE, P.J., STOFFYN-EGLI, P., and VAN WAGONER, N.A. (1986)

Geological constraints for tectonic models of the Alpha Ridge; J. Geodynamics, Vol. 6, pp. 215-236, CESAR Contr. No. 31..

3408 NARBONNE, G.M., and DIXON, O.A. (1987)

Faunal succession in Upper Silurian sponge reefs, Somerset Island, N.W.T.; Abstract in, CSPG Canadian Reef Research Sym., January 27-30, 1987, Banff, Alberta, Program with Abstracts, p. 46.

Small (5-35 m diameter) reef mounds occur sporadically throughout the two deepest-water intervals in the shallow subtidal Douro Formation. Reefs grew on a broad carbonate platform, in warm, tranquil, turbid waters of approximately normal marine salinity. Reefs were constructed primarily by baffling organisms, and underwent synsedimentary lithification and minor erosion by storm waves and boring organisms. Maximum topographic relief was approximately 3 m.

The reefs exhibit a well-developed vertical zonation. Basal deposits consist of a lens of crinoidal wackestone to grainstone with abundant crinoid holdfasts and locally common bryozoans, solenoporacean algae and rhynchonellid brachiopods. This is abruptly overlain by lime mudstone with abundant lithistid sponges (>35% by volume), which comprises the main mass of the reef. The sponge-rich lime mudstone grades upwards into crinoidal wackestone with abundant tabulate and rugose corals, and fewer lithistid sponges, calcareous algae, bryozoans and stromatoporoids. This zonation apparently reflects initial stabilization of the substrate by rooted organisms (Crinoid Stage), colonization by turbidity-tolerant baffling organisms (Sponge Stage), and diversification of reef-building organisms (Coral Stage). Stages appear to be intrinsic to the reefs, and do not reflect sea level fluctuations. Similar zonations in Middle Ordovician, Upper Jurassic and Holocene sponge reefs have been attributed to both intrinsic and extrinsic controls.

3409 NARBONNE, G.M., and PACKARD, J.J. (1983)

Trace Fossils in Siluro-Devonian Tidal Flat to Distal Basin Slope Carbonates of Arctic Canada; Abstract in Amer. Assoc. Petroleum Geologists Annual Convention, April 17-20, 1983, Dallas, Texas, Vol. 67, No. 3, p. 524.

Upper Silurian and Lower Devonian carbonates of Somerset, Griffith, Cornwallis, and Devon Islands (Arctic Canada) were deposited under conditions which ranged from tidal flat in the south to basin slope in the north. Trace fossils occur commonly in this succession. Planolites, Palaeophycos, Chondrites, and Skolithos are ubiquitous throughout the sequence. Seven commonly occurring ichnogenera exhibit restricted environmental conditions: Polarichnus is confined to tidal flat deposits, Zoophycos and Pilichnia are most common in deep subtidal shelf and upper basin slope deposits, and Phycodes, Lockeia, Taenidium, and Cruziana occur predominantly in basin slope deposits. Seven other ichnogenera, Arenicolites, Arthraria, Cochlichnus, cf. Furculosus, Helicodromites, Teichichnus, and cf. Thalassinoides, occur only very rarely.

Trace fossil assemblages of the tidal flat and subtidal shelf carbonates are broadly similar to the Skolithos and Cruziana ichnofacies reported from environmentally equivalent siliciclastic deposits. Similarly, the assemblage of the deep subtidal-upper basin slope carbonates resembles the environmentally equivalent Zoophycos ichnofacies. In contrast, the assemblage of the basin slope carbonates comprises abundant resting and feeding traces (Cruziana ichnofacies) whereas assemblages of siliciclastic slope deposits are dominated by complex grazing traces and graphoglyptids (Nereites ichnofacies). The relative scarcity of arthropod traces throughout this carbonate sequence probably reflects diagenetic alternation of bedding surfaces.

3410 NASSICHUK, W.W., and HENDERSON, C.M. (1986)

Lower Permian (Asselian) ammonoids and conodonts from the Belcher Channel Formation, southwestern Ellesmere Island; in Current Research, Part B, Geol. Surv. Can., Paper 86-1B, pp. 411-416.

A diverse fauna of Lower Permian ammonoids, including representatives of Neopronorites, Daixites, Boesites, Agathiceras, Glaphyrites, and Emilites is associated with representatives of the conodont Streptognathodus and the fusulinids Pseudofusulina and Pseudofusulinella in the lower part of the Belcher Channel Formation at Blind Fiord, southwestern Ellesmere Island. Ammonoids, conodonts and fusulinaceans all indicate an earliest Permian (Asselian) age.

3411 NASSICHUK, W.W., DAVIES, G.R., and NAMET, B.L. (1986)

Microcodiaceans in the Viséan Emma Fiord Formation, Devon Island, Arctic Canada; in Current Research, Part B, Geol. Surv. Can., Paper 86-1B, pp. 467-470.

The Lower Carboniferous (Viséan) Emma Fiord Formation on Grinnell Peninsula of Devon Island contains an abundance of the enigmatic algae Microcodium and Palaeomicrocodium in sediments of lacustrine origin. The microcodiaceans are associated with a variety of megaplants, ostracodes, serpulid worms, and phosphatic bone fragments. In other reported occurrences, Palaeomicrocodium has been found in rocks of shallow marine origin ranging in age from Devonian to Permian. The Emma Fiord discovery confirms that Palaeomicrocodium also occurs in nonmarine settings.

3412 NENTWICH, F.W. (1987)

Stratigraphy and sedimentology of the Ordovician and Silurian Brodeur Group, Northern Brodeur Peninsula, Baffin Island; unpub. Ph.D thesis, Dept. Geology, Univ. Alberta, Edmonton, Alberta, 457 p.

The Ordovician-Silurian Brodeur Group of northwestern Brodeur Peninsula comprises the Baillarge and Cape Crauford formations, a succession of shallow shelf carbonates deposited hundreds of kilometres southeast of the Franklinian Geosyncline. The Baillarge Formation is divided into two members. Member A (140 m) at the base comprises variously dolomitic interstratified carbonates and subsidiary carbonate solution breccia. Member B (374 m), of Late Ordovician to Early Silurian age, comprises mottled dolomitic limestone and rare carbonate solution breccia. A major unconformity in which Middle Ordovician strata are missing separates the two members. The overlying Early Silurian (Llandoverian) Cape Crauford Formation is divided by a regional unconformity (representing

a buried karst surface) into upper and lower members. The lower member varies in thickness from 130 m in the southwest near the axis of the Melville High to 208 m in the northeast. It comprises acyclic but shallowing-up variously dolomitic interstratified carbonates and carbonate solution breccia. During subaerial exposure at the top of the lower member diagenesis included dolomitization, calcification, stylolitization, silicification, leaching, brecciation and formation of diagenetic coated grains and clasts. Caves, formed by carbonate dissolution, collapsed to produce both concordant and discordant breccias. This differs from earlier views based on evaporite dissolution as the mechanism of brecciation. The concordant breccias are tabular, laterally continuous for several kilometres and occur preferentially in light coloured carbonates, especially limestone. Most of the discordant breccias are 'inverted-cone-shaped' pipes many of which, but not all, extend down to meet concordant breccias. Where dissolution was most extreme, collapse structures, including grabens (paleodolines) were formed. The upper member of the Cape Crauford Formation is divided into unit A (110 m) and an overlying unit B (42 m). Unit A is a fossiliferous pervasively dolomitized succession and unit B is similar to the lower member of the Cape Crauford Formation. More than one episode of karsting is recorded by solution breccias in the upper member and by rare collapses of the upper into the lower member.

3413 MENTWICH, F., and JONES, B. (1984)

Sedimentology and stratigraphy of the Silurian strata of northern Brodeur Peninsula, Baffin Island; in Contributions to the Geology of the Northwest Territories, Vol. 1, ed. J.A. Brophy, Indian & Northern Affairs, Yellowknife, N.W.T., EGS-1984-6, pp. 85-89.

The Brodeur Group on northern Brodeur Peninsula comprises the Silurian Cape Crauford Formation and part of member B of the Baillarge Formation.

The Cape Crauford Formation consists of late Silurian partly dolomitic marine shelf limestones. Stratified and pipe breccia bodies occur in members A and B of the Cape Crauford Formation. Evidence currently available suggests that the brecciation resulted from interstratal karsting.

An unconformity at the top of member B of the Cape Crauford Formation attests to the subaerial exposure of this area in late Silurian time. It was during this period that the breccias were formed. The overlying member C of the Cape Crauford Formation consists of dolostone which is preserved only in the high-relief areas of the northwestern part of the peninsula.

3414 MENTWICH, F.W., and JONES, B. (1985)

Geology of northwestern Brodeur Peninsula, Baffin Island, N.W.T.; in Contributions to the Geology of the Northwest Territories, Vol. 2, ed. J.A. Brophy, Indian & Northern Affairs, Yellowknife, N.W.T., EGS-1985-6, pp. 71-83.

On northwestern Brodeur Peninsula, Baffin Island, the Brodeur Group consists of the Baillarge and Cape Crauford formations, a succession of Ordovician and Silurian carbonates deposited in shallow, low-latitude tropical seas. The Baillarge Formation is 514 m thick and comprises members A and B. Member A (140 m) consists of dolostone interbedded with limestone (in part breccia) while member B (374 m) consists of thick massive dolomitic limestone containing minor solution breccias. The overlying Cape Crauford Formation, which is up to 360 m thick, is divided into lower and upper members. The lower member is 130 to 208 m thick and consists of limestone (in part solution breccia) interbedded with variously dolomitic limestone and dolostone. The upper member is 152 m thick and is divided into units "a" and "b". Unit "a" (110 m) consists of massive buff dolostone that has been mapped over most of the peninsula. Unit "b" (42 m), which overlies unit "a", is lithologically similar to the lower member of the Cape Crauford Formation. An unconformity between the upper and lower members of the Cape Crauford Formation is recognized throughout the area and represents a period of subaerial exposure in the Llandoverian. This exposure generated the paleokarst breccias of the lower member of the Cape Crauford Formation. It is suggested that the breccias were formed by the dissolution of limestone rather than evaporites, an interpretation that gives the area a high lead-zinc mineral potential.

3415 NIXON, F.M. (1988)

Till sampling and presentation of physical and geochemical data from western Victoria Island, Northwest Territories; Geol. Surv. Can., Paper 88-15, 36 p.

A co-ordinated till sampling program was one component of a large mapping project on western Victoria Island, Northwest Territories. The program was designed to allow evaluation of the reproducibility of results and of the spatial distribution of variance through analysis of variance techniques. Sample characteristics measured include granulometry, carbonate content, and trace element geochemistry. Data from site observations and laboratory analyses are appended in a table and on maps. Analysis of variance indicates that certain variables strongly represent regional variation in till whereas others show considerable variability below the scale of sampling density. This information will be valuable when using the data and has contributed to a subsequent sampling design in an adjacent area.

3416 NORRIS, D.K. (1986)

Lower Devonian Road River Formation on the north flank of Romanzof Uplift, northern Yukon Territory; in Current Research, Part A, Geol. Surv. Can., Paper 86-1A, pp. 801-802.

Late Early Devonian conodonts have been discovered in black shales and chert of the Road River Formation in the lower Firth River area, northern Yukon Territory. These shales are overlain with angular unconformity by the Upper Triassic Shublik Formation. The interregional sub-Upper Triassic unconformity, therefore, is now precisely defined at this point and the widespread nature of the lower and middle Paleozoic black shale basin in the northern mainland west of the Mackenzie Delta is further refined.

3417 OKULITCH, A.V., PACKARD, J.J., and ZOLNAI, A.I. (1986)

Evolution of the Boothia Uplift, Arctic Canada; Can. J. Earth Sci., Vol. 23, pp. 350-358.

The Boothia Uplift extends 1000 km northward from the northern Canadian Shield into the Arctic Archipelago. Consisting of a core of Archean(?) to Aphebian gneissic units and a cover of Proterozoic to Devonian strata of the Arctic Platform and Franklinian Miogeocline, it formed during several minor pulses of uplift in the late Proterozoic and early Paleozoic and a major episode of tectonism during the Siluro-Devonian. Although it has long been regarded as a "horst" or vertical block uplift, compilation of new and previous data suggests that the uplift can be interpreted as a major, west-directed, imbricate mass of crystalline basement mantled by faulted and drape-folded cover. Details of the vertical component of movement have been provided by sedimentological and stratigraphic studies. Uplift increases northward from the craton to a maximum of 5 km. Estimates of horizontal movement, predicated on assumed fault dips, could be as much as 30 km.

Major tectonism of the Boothia Uplift was approximately coeval with uplift on southeastern Ellesmere Island and on northern Axel Heiberg Island, folding and low-grade metamorphism on northernmost Ellesmere Island, and west-directed thrusting and folding on Greenland. The plate tectonic interactions responsible for these events remain obscure; a general regime of west-directed compressive stresses associated with late stages of the Caledonian Orogeny may have been present.

3418 OSADETZ, K.G., and MOORE, P.R. (1988)

Basic volcanics in the Hassel Formation (Mid-Cretaceous) and associated intrusives, Ellesmere Island, District of Franklin, Northwest Territories; Geol. Surv. Can., Paper 87-21, 19 p.

Subalkaline basic volcanic rocks with tholeiitic rock series affinities are interbedded with non-marine sandstones in the Hassel Formation (mid-Cretaceous) in the vicinity of Lake Hazen, northern Ellesmere Island. Nonmarine volcanic flows are the extrusive equivalents of a significant complex of sills and dykes that are exposed in Tertiary (Eurekan) structures between Tanquary Fiord and Lake Hazen. Two distinct low- and high-phosphorus parental olivine tholeiite magmas are identified on the base of P_2O_5, FeO*, and TiO_2 abundances. Both parental magmas can be derived from an undepleted mantle source with a normal phosphorus abundance ($P \sim 200$ ppm), by different degrees of equilibrium partial melting. The low-phosphorus parental olivine tholeiite (0.29 wt % P_2O_5) can be formed by approximately 12 percent partial melting of the mantle source: this rock exhibits minor element characteristics similar to oceanic tholeiites. The high-phosphorus parental olivine tholeiite resulted from less than 12 percent partial melting of a similar mantle source: it exhibits certain alkaline characteristics (high TiO_2 and P_2O_5). The low-phosphorus parental magma fractionated $\sim$20 percent olivine ± clinopyroxene and plagioclase. The high-phosphorus parental magma fractionated undetermined amounts of similar phases to produce derivative liquids that intruded exposed crustal levels. The low-phosphorus magma was extruded without further fractionation, while the high-phosphorus magma underwent extensive fractionation after emplacement in the rocks of the Sverdrup Basin (<2.5 km), resulting in at least one layered sill. Some flows were derived from the high-phosphorus magma late in its crystallization history, past the peak of iron enrichment. It is deduced that these basic igneous rocks represent magmatic activity within the contiguous North American - Barents Shelf craton, during the late stages of the opening of the Amerasian Basin by the anticlockwise rotation of northern Alaska and portions of northern Siberia.

3419 OSTERTAG, R., ROBERTSON, P.B., STÖFFLER, D., and WÖHRMEYER, C. (1985)

First results of a multidisciplinary analysis of the Haughton Impact crater, Devon Island, Canada, III Petrography and Shock Metamorphism; Abstract in, Proc. XVI Lunar and Planetary Science Sym., Houston, Texas, pp. 633-634.

3420 PACKARD, J. (1986)

Substrate cementation in association with crinoid holdfast networks; Abstract in GAC, MAC, CGU Joint Annual Meeting, Carleton Univ., Ottawa, Ontario, May 19-21, 1986, Program with Abstracts, Vol. 11, No. 111.

In the medial foreslope facies of the Upper Silurian Barlow Inlet Formation on Cornwallis Island, Arctic Canada, there occurs abundant, in situ, crinoid rhizoidal holdfasts. Nests of crinoids evidently colonized both autochthonous deposits of hemipelagic lime mud and the upper surfaces of debris flows. Intimately and exclusi-

vely associated with the holdfast networks, are tubules that in cross-section exhibit distinct, concentric bands of light and dark colored micrite and microspar, surrounding a centre of calcite spar. The maximum diameter of the tubules is 5mm, and the calcite spar centres range in size from 300 to 600 microns. Statistically, these size parameters are indistinguishable as a separate population from diameters of cirri and their respective lumens. The spatial and geometric affinities of the tubules and cirri suggest some mutual (genetic) relationship.

A hypothesis is advanced that explains the tubules as biocatalytic cementation phenomena, produced during the progressive centripetal resorption of the mesodermal skeleton of select holdfast cirri. The skeletal resorption and cementation process may have been a stabilization strategy, or possibly a response to periodic anoxia of basin waters.

3421 PACKARD, J.J. (1987)

A Lower Ordovician thrombolite ?reef complex, Ellesmere Island, Arctic Canada; Abstract in, CSPG Canadian Reef Research Sym., January 27-30, 1987, Banff, Alberta, Program with Abstracts, p. 97.

In southern Ellesmere Island, the top of the Christian Elv Formation (conodont fauna C, Tremadocian Age) is marked by a 28 m thick series of stacked thrombolitic biostromes. Individual thrombolitic units are up to 4.7 m thick, and consist of a massive boundstone of mottled dolomitic limestone with a distinctive clotted texture and extremely discontinuous cryptalgal laminae. Porostromate algae are apparently absent, and the cryptalgal fabric is thrombolitic throughout (i.e. no lateral or vertical gradation to stromatolitic boundstone was noted). Between thrombolite units are thin beds of apparently shallow-water origin, including chert-rich storm-laminated dolosiltites, intraclastic dolorudites and small domal stromatolites.

The thrombolite complex occupies a consistent stratigraphic position in sections 100 km apart, and the inferred lateral continuity of this interval is supported by regional mapping over 10's of km. Either there was the synchronous development of a very widespread cryptalgal facies, or the rapid progradation of a linear thrombolite trend (barrier reef). The overlying beds belong to the evaporitic Baumann Fiord Formation, interpreted as representing primarily deposits of an extensive, shallow salina. Speculatively, the thrombolite biostromes may have acted as an organic barrier, that served to limit circulation and thus promote supersaturation of basin waters with respect to gypsum.

3422 PACKARD, J., and DIXON, O.A. (1985)

The Barlow Inlet carbonate platform: a major Late Silurian paleogeographic element of diastrophic origin and demise; Abstract in Geol. Assoc. Can.-Mineralogical Assoc. Canada Joint meeting, Univ. New Brunswick, Fredericton, N.B., May 15-17, 1985, Program with Abstracts, Vol. 10, p. A46.

The Upper Silurian Barlow Inlet Formation of Cornwallis and adjacent islands in arctic Canada, was laid down on an attached interior platform with a rimmed accretionary shelf margin. Locally the shelf margin may have been stepped, and its occurrence predetermined by subjacent faults bounding the Boothia Horst. Wave stress and clastic pollution were both minimal on the platform, which bordered an equatorial meromict sea in an area with an arid to semi-arid climate. Both shelf and off-shelf were well-differentiated and seven major facies associations (superfacies) are recognized, including: tidal flat, restricted shelf lagoon, proximal back-barrier, shelf edge, proximal foreslope, medial foreslope, and distal foreslope. Biocumes (embracing biostromes and bioherms) occur commonly in many superfacies, and eleven general categories of biocumes are identified. The platform interior is characterized by two types of shallowing-upward cycles. Overall the BARLOW INLET PLATFORM bears considerable resemblance to Mid- to Late Devonian rimmed shelf complexes.

The Barlow Inlet Platform originated as a result of structural modifications to a precursor carbonate ramp, and subsequent acquisition by rapid organic growth and sediment accumulation of a stable shelf margin and extensive lagoon/tidal flat system. This initial development is synthesized into three phases corresponding to active or more quiescent stages of the Cornwallis Disturbance: (1) pre-epeirogenic phase represented by carbonate deposition on the DOURO RAMP; (2) epeirogenic phase represented by deposition of prodeltaic muds on the HOTHAM CLINOFORM; and (3) immediate post-epeirogenic phase marked by transgression across the embryonic Barlow Inlet Platform. Platform demise occurred with renewed tectonism (early Devonian pulse of the Cornwallis Disturbance).

3423 PACKARD, J.J., and DIXON, O.A. (1987)

Bioherms of the Upper Silurian Barlow Inlet Platform, Arctic Canada; Abstract in, CSPG Canadian Reef Research Sym., January 27-30, 1987, Banff, Alberta, Program with Abstracts, p. 99.

The Barlow Inlet Platform, centered about present-day Cornwallis Island, Arctic Canada, was an areally-extensive Late Silurian rimmed shelf that developed on the northeasterly cratonic margin of Laurentia. A wide variety of buildup types populated the Platform in settings ranging from medial foreslope to restricted shelf interior. Most of the observed organic edifices fall into one of the following categories: (1) lithistid sponge - algal mud mounds (medial foreslope); (2) mucophyllid-dominated mud mounds (medial foreslope); (3) diverse community mud mounds (proximal foreslope);

(4) stromatoporoid-crinoid rubble buildups (proximal foreslope); (5) tabular stromatoporoid - coral barrier reefs (shelf-edge); and (6) dendroid coral-capped fenestral mud mounds (restricted shelf interior).

The largest structures, the lithistid sponge mud mounds, have outcrop dimensions in excess of 60 m by 500 m (height X width) whereas the smallest discrete buildups (mucophyllid and diverse community mud mounds) are patch reef mounds less than 5 m high.

With some exceptions, the spectrum of reefal facies in this Late Silurian rimmed shelf, is closely comparable to that seen in the well-studied Mid- and Upper Devonian reef complexes of Europe, Australia and Western Canada. This comparison suggests that reef community evolution was in a period of relative stasis for the 40 m.y. prior to the Frasnian-Famennian faunal crisis.

The hydrocarbon reservoir potential of the proximal foreslope and shelf edge is excellent, and in particular the stromatoporoid-crinoid rubble buildups would form attractive exploration targets in the subsurface.

3424 PACKARD, J., and MAYR, U. (1987)

Pridolian-Gedinnian downslope buildups in the vicinity of Cardigan Strait, Arctic Canada: a reconnaissance impression; Abstract in, CSPG Canadian Reef Research Sym., January 27-30, 1987, Banff, Alberta, Program with Abstracts, p. 98.

Spectacularly exposed in seacliffs along the southeast coast of Ellesmere Island and southwestern Kent Island, as well as in the interior of Colin Archer Peninsula, are pinnacle reefs of Pridolian to Gedinnian Age. These dolomitized buildups are apparently circular in plan view. They achieve stratigraphic thicknesses of 150 m and may exceed 400 m in diameter. Eight such reefs have been identified in outcrop, of which three have been examined. The buildups are enclosed by, and interfinger with, dark shales and argillaceous carbonates of the Devon Island Formation, a progradational fondothem-clinothem wedge formed at the basin margin of a meromict sea.

The principal biotic components of these buildups include: fasciculate and solitary rugose corals, crinoids, lamellar stromatoporoids, dendroid tabulate corals, favositids, gastropods, bryozoans, and atrypoid and rhynchonellid brachiopods. A unique community succession is not apparently developed although limited observations suggest that fasciculate rugose corals and lamellar stromatoporoids are most prevalent in basal portions of these buildups, skeletal organisms are generally rare in middle parts, and crinoids, brachiopods and bryozoans occur commonly towards the top of the structures. The reef core is stratigraphically dissected by argillaceous seams that probably represent successive suffocation horizons. The maximum synoptic relief of the reefs determined by tracing isochronous shale seams into off-reef areas, is in the order of 20 m.

A distinctive feature of these buildups is the pervasive occurrence of dolomitized, isopachous, fibrous cements. Their morphology and the presence of interlaminated sediment suggest a submarine origin. Although stromatactoid-like, the characteristic digitate roof and flat base is not developed.

Useful comparison can be made to the much younger Nisku pinnacle reefs of Frasnian Age found in the West Pembina area of Alberta, Canada.

3425 PARAMESWARAN, V.R., JOHNSTON, G.H., and MACKAY, J.R. (1985)

Electrical potentials developed during thawing of frozen ground; in Proc. Fourth Inter. Sym. on Ground Freezing, Sapporo, Japan, August 5-7, 1985, Nat. Res. Council, Vol. 1, pp. 9-16.

Electrical potentials developed during thawing of the active layer in frozen ground have been measured at a test site in Inuvik, Northwest Territories. Probes containing copper electrodes spaced at regular intervals were installed vertically in a clay hummock, in an ice-rich soil at the junction of three hummocks, and in a sandy gravel and reconstituted clay in wax-coated cardboard tubes placed in an adjacent hummock. The maximum voltage measured across the thaw boundary was of the order of 500 mV in the fine-grained soil and about 200 mV in the coarse-grained soil. The difference may be due to the large amounts of moisture in the fine-grained soil.

3426 PARKINS, W.G. (1986)

The coral Thuliocyclus prominens N. Gen. and Sp. (Rugosa: Palaeocyclidae) from the Upper Silurian of the Canadian Arctic Archipelago; J. Paleontology, Vol. 60, No. 1, pp. 53-60.

Twenty-two specimens of Thuliocyclus prominens, a new palaeocyclid rugose coral genus and species, on a loose slab presumably from the lower Pridolian Barlow Inlet Formation at Cape Rescue on Cornwallis Island, Northwest Territories, Canada, provide a good growth series from neanic to ephebic stages. The new genus shares morphological characteristics with both typical Silurian Palaeocyclidae and more advanced Devonian Hadrophyllidae.

3427 PEDDER, A.E.H. (1986)

Species of the rugose coral genus Minussiella from the Middle Devonian of western and Arctic Canada; in Current Research, Part B, Geol. Surv. Can., Paper 86-1B, pp. 471-488.

The genus Minussiella Bul'vanker, 1952, which was previously recognized only in the Middle Devonian

of southern Siberia and western Mongolia, is shown to include four Canadian species. Minusiella bathurstensis sp. nov. and M. goodbodyi sp. nov. are described from an Eifelian (costatus Zone) carbonate on Bathurst Island, Canadian Arctic Archipelago. Minussiella cornus (McLaren) and M. conjuncta sp. nov. are described from the Givetian (probably Middle varcus Zone) organic reef facies of the type Horn Plateau Reef in southwestern District of Mackenzie.

3428 POEY, J-L. (1985)

The Silurian Carbonate Shelf-to-Basin Transition, S.W. Ellesmere Island; Abstract in GAC, MAC, Joint Annual Meeting, Univ. New Brunswick, Fredericton, N.B., May 15-17, 1985, Program with Abstracts, Vol. 10, p. A49.

The Upper Ordovician to Lower Devonian sequence on Svendsen Peninsula shows marked lateral and vertical facies changes. Vertical facies changes represent the establishment during the Early Silurian of a well differentiated shelf-to-basin transition, due to fault-created collapses of an extensive portion of the marginal shelf. For the remainder of the Silurian, interfingering facies reflect periodical outbuilding of the shelf alternating with minor collapses. A major latest Silurian collapse of the shelf-edge resulted in an extensive S.E. transgression of basinal conditions.

Lateral facies changes reflect progressive deepening from a carbonate shelf, N.W. into the Hazen Trough, the axial portion of the Franklinian Basin. Prior to the Early Silurian collapse, the Irene Bay Fm. and overlying lower part of the Allen Bay Fm. accumulated on ramp-like shelf. They consist mostly of mottled limestones that change gradually upsection to massive dolostones, and reflect upward shallowing conditions. Slope conditions predominated within the study area for the remainder of the Silurian, as evident from the appearance of mass flow deposits. Interfingering proximal slope and shelf-edge deposits have been designated the Allen Bay Fm-Read Bay Gp undivided. Dominated by calci turbidites, they contain however abundant debris flows, as well as olistostromes incorporating reef blocks. Distal slope deposits of the Cape Phillips Fm consist mostly of hemipelagic sediments alternating with fine calciturbidites which are distal equivalents of the coarser mass flows. The major collapse of the latest Silurian resulted in the spread of basinal "flysch" silty carbonates of the Devon Island Formation.

3429 POEY, J-L. (1988)

Stratigraphy and depositional environments of an Upper Ordovician to Lower Devonian shelf-to-basin transition, Svendsen Peninsula, Ellesmere Island, N.W.T.; unpub. M.Sc. thesis, Univ. Ottawa, 257 p.

The upper Ordovician to Lower Devonian sequence on Svendsen Peninsula shows marked lateral and vertical facies changes. Vertical facies changes represent the establishment during the Early Silurian of a well differentiated shelf-to-basin transition, due to fault-created collapses of an extensive portion of the marginal shelf. For the remainder of the Silurian, interfingering facies record a series of shallowing-upward sequences interpreted as reflecting periodic outbuilding of the carbonate shelf alternating with minor collapses along the shelf-edge. A major latest Silurian collapse of the shelf-edge resulted in an extensive southeastward migration of basinal conditions.

Lateral facies changes reflect progressive deepening from a carbonate shelf northwestward into the Hazen Trough, the axial portion of the Franklinian Basin. Before the Early Silurian collapse, the Irene Bay Formation and overlying lower portion of the Allen Bay Formation accumulated on a ramp-like shelf which gradually deepened northwestward up to an abrupt gradient marking the margin of the laterally restricted Hazen Trough. The Irene Bay Formation and the lower portion of the Allen Bay Formation consist mostly of argillaceous and dolomitic mottled limestones, that change gradually upsection to massive, siliceous and bituminous dolostones, and reflect upward shallowing conditions. Slope conditions predominated within the study area for the remainder of the Silurian, as evident from the appearance of mass flow deposits. Interfingering proximal slope and shelf-edge deposits have been designated the Allen Bay Formation - Read Bay Group undivided. Dominated by calciturbidites, they contain abundant debris flows, as well as spectacular, though rare, olistrostromes incorporating undolomitized reef blocks. Distal slope deposits of the Cape Phillips Formation consist mostly of graptolitic hemipelagic sediments alternating with fine calciturbidites which are distal equivalents of the coarser mass flows. The major collapse of the latest Silurian resulted in the spread of basinal "flysch" silty carbonates of the Devon Island Formation throughout the study area.

3430 POHL, J., ECKSTALLER, A., ROBERTSON, P.B., and HAJNAL, Z. (1985)

First results of a multidisciplinary analysis of the Haughton Dome, impact structure, Devon Island, Canada, IV. Geophysics; Abstract in, Proc. XVI Lunar and Planetary Science Sym., Houston, Texas, pp. 669-670.

As part of the multidisciplinary investigations of Haughton Dome gravity, magnetic and seismic field measurements were made. Here preliminary results of the gravity and magnetic studies are presented.

3431 POHL, J., ECKSTALLER, A., and ROBERTSON, P.B. (1988)

Gravity and Magnetic Investigations in the Haughton Impact Structure, Devon Island, Canada; Meteoritics, Vol. 23, pp. 235-238.

The results of a new gravity survey show that the Haughton impact structure is associated with a 24 km diameter negative Bouguer gravity anomaly with a maximum amplitude of -12 mgal. A local minimum with a half-width of 2 km and an amplitude of -4 mgal is located at the center of the structure. A positive magnetic total field anomaly with a half-width of 0.6 km and an amplitude of 700 nT coincides with the local central gravity anomaly. The overall negative gravity anomaly is explained by lowered rock densities due to impact-related fracturing in the crater area. The central gravity and magnetic anomalies are believed to be due to highly shocked and heated sedimentary and crystalline basement rocks forming the unexposed peak of the central uplift in the Haughton impact structure.

3432 POLLARD, W.H., and FRENCH, H.M. (1984)

The groundwater hydraulics of seasonal frost mounds, North Fork Pass, Yukon Territory; Can. J. Earth Sci., Vol. 21, No. 10, pp. 1073-1081.

Seasonal frost mounds occur in the North Fork Pass area in response to increased hydraulic potentials in perennial, spring-fed groundwater systems. Geochemical and isotope analyses indicate that local precipitation is the source of water for flow systems discharging from the springs. The direct measurement of pressure potentials in a number of frost blisters and icing blisters, undertaken in March 1982, gave values ranging from 30 and 81 kPa for mounds approximately 2.0 m high. These pressures exceed theoretical, calculated values and are attributed to the tensile strength of the soil and (or) ice overburden. In genetic terms, seasonal frost mounds should be clearly differentiated from other morphologically similar features such as palsas.

3433 POLLARD, W.H., and FRENCH, H.M. (1985)

The internal structure and ice crystallography of seasonal frost mounds; J. Glaciology, Vol. 31, No. 108, pp. 157-162.

The crystal character of the ice core within frost blisters supports the hypothesis that groundwater injection into residual zones of the active layer followed by rapid freezing is the primary growth mechanism for these features. The ice core is characterized by an upper zone of relatively small randomly arranged equigranular ice crystals which change with increasing depth to columnar anhedral crystals, commonly exceeding 200 mm in length, and with crystal diameters ranging between 25 and 35 mm. Petrofabric analyses show that the c-axis orientations are normal to crystal elongations, with crystal growth along the basal plane in an a-axis direction. These observations eliminate ice segregation as a possible growth mechanism, thereby distinguishing seasonal frost mounds from palsas.

3434 POLLARD, W.H., and de KROM, V. (1988)

Ground ice characteristics of Herschel Island, Yukon Territory; Abstract in, GAC, MAC, CSPG Joint Annual Meeting, May 23-25, 1988, St. John's, Newfoundland, Program with Abstracts, Vol. 13, p. A100.

The term "ground ice" is used, to define frozen moisture existing beneath the ground surface. In theory, this definition includes syngenetic and epigenetic ice occurring within both seasonally and perennially frozen ground. The aim of this paper is to describe the range in ground ice occurrence and characteristics at three locations on Herschel Island, including: (1) Collinson Head, (2) Thetis Bay and (3) Avadlek Spit. Field investigations utilized natural permafrost sections exposed in thaw slumps and coastal bluffs. At each site, vertical sections were measured and samples were taken for moisture content, geochemical and petrographic analyses. This paper focuses mainly on the cryostratigraphic and petrographic characteristics of the ground ice. Ground ice occurrence ranges from pore ice and small segregated ice lenses and veins to various forms of massive ice, including: wedge ice, thick tabular layers of segregation ice, and buried surface ice. Ice contents range from 36% to 3000% (on a dry weight basis). The widespread occurrence of thermokarst suggests that high ice contents may be common. Ground ice petrography focused on the various massive ground ice bodies which are characterized by medium to small crystal size and fabrics ranging from random to preferred vertical patterns.

3435 RACHEBOEUF, P.R. (1987)

Upper Lower and Lower Middle Devonian Chonetacean Brachiopods from Bathurst, Devon and Ellesmere Islands, Canadian Arctic Archipelago; Geol. Surv. Can., Bull. 375, 29 p.

Brachiopods of the Superfamily Chonetacea from the Canadian Arctic Archipelago, which are described and illustrated here, were collected mainly by Brice in 1971 and 1972. All the material is from Emsian strata of the Blue Fiord and Bird Fiord formations on Bathurst, Devon and Ellesmere islands. All the well documented citations in the literature on arctic Devonian chonetids are revised and discussed in order to get as complete a view as possible of the superfamily in the area studied. The present work is the first comprehensive contribution to the knowledge of Devonian chonetacean brachiopods from the Canadian Arctic Archipelago. Thirteen species are described and their biostratigraphic value is established and compared with the conodont zonation.

The taxa identified are: Philippotia (Philippotia) briceae sp. nov., Philippotia? (Chlupacina) sp., Johnsonetes ellesmerensis gen. et sp. nov., J. arcticus gen. et sp. nov., Caplinoplia rectispina (Khalfin?), Devonochonetes? maclareni sp. nov.,

Sinochonetes wangi sp. nov., Sinochonetes sp. nov. aff. S. wangi sp. nov., Dagnachonetes quietus sp. nov., Dagnachonetes? grinnellensis sp. nov., Dagnachonetes? pordenensis sp. nov., Parachonetes macrostriatus and Chonostrophiella cynthiae sp. nov.

Paleogeographic affinities of the arctic Devonian chonetid faunas with those of the Old World Realm are very strong. The same species, or very closely related ones, occur in western Siberia (Altaï), in Bohemia, China, Australia, and, in North America, in Nevada and the Yukon. The arctic occurrence of the genus Chonostrophiella has lead to a re-evaluation of the paleogeographic significance of the genus and indicates an affinity with the Eastern Americas Realm.

3436 RAMPTON, V.N. (1988)

Quaternary geology of the Tuktoyaktuk coastlands, Northwest Territories; Geol. Surv. Can., Memoir 423, 98 p.

The Tuktoyaktuk Coastlands consist of a thick wedge of Pleistocene marine and fluvial sediments that contain much ground ice and have been modified by glaciation and thermokarst. East of Nicholson Peninsula the Stanton Sediments, consisting of a basal clay member, lower complex member, thinly bedded member, and an upper sandy member, represent Middle Pleistocene deposition in marine and alluvial environments. West of Nicholson Peninsula, Kendall sediments and Hooper clay of marine origin underline the Kidluit Formation of alluvial origin. Kidluit Formation is overlain by the Kittigazuit Formation, a thick fine grained deltaic sand of likely glaciofluvial origin.

Northwesterly moving continental (Laurentide) ice defined a glacial limit on Cape Bathurst peninsula around unglaciated terrain to the north during the Mason River Glaciation of Middle Pleistocene age. Major strandlines marking marine limits were formed in this area during the Horton and Harrowby marine episodes (seas) of Middle Pleistocene age. Also in this region low marine benches, some inset into glaciated terrain, are likely Sangamonian in age as they contain organic-bearing deposits (Ikpisugyuk Formation) indicative of interglacial climate.

Northwesterly flowing continental ice again covered most of the area during the Toker Stade of Early Wisconsinan age. Sediments were glacially deformed in peripheral areas; till (Toker Point Member) and outwash (e.g., Turnabout Member, Garry Island Member, and Cape Dalhousie Sands) grading to relatively high sea levels were deposited. During the likely equivalent Franklin Bay Stade, westerly moving ice from Amundsen Gulf impinged on the eastern coast of Cape Bathurst peninsula. Ground ice, common to most of the area, was formed during deglaciation. During the Sitidgi Stade of Late Wisconsinan age, Laurentide ice persisted in the southern Mackenzie Delta and Sitidgi Lake areas and deposited till (Sitidgi Member). Sediments of a large proglacial valley train (Portage Point Sands) and a large proglacial lake (Eskimo Lakes Member) formed in the unglaciated Eskimo Lakes area during this stade.

Extensive thermokarst activity during the Holocene produced thermokarst deposits (Parsons Lake Formation) and resulted in the formation of the ice-cored topography. During Late Wisconsinan and Holocene, valleys that had been eroded during the Wisconsinan were drowned and filled with thick fine grained alluvium. The Mackenzie Delta, consisting mainly of fine sand and silt (Aklavik Formation) and characterized by many thermokarst lakes, was formed. Rapid retreat of exposed coastlines has occurred. Periglacial processes and minor eolian activity and peat accumulation continued throughout the Holocene.

Ground ice and subsidence resulting from its thaw represent major hazards to development as does flooding of low-lying areas. Sand fill is a common resource, but coarser aggregate is only locally available.

3437 RAMPTON, V.N. (1988)

Terrain Analysis and Mapping Services; in Proc. Fifth International Conf. on Permafrost, August 2-5, 1988, Trondheim, Norway, Poster Presentation A5.14.

Massive tabular ice and icy sediments, underlie hills and ridges within and proximal to the glacial limit on the Tuktoyaktuk Peninsula. Sediments in depressions and radiocarbon dates obtained from these sediments indicate that massive ice and icy sediments underlaid most landscape now occupied by basins until the ice melted during the hypsithermal. Oxygen isotope values from the massive ice as reported by Mackay (1983) suggest that it has a glacial or meltwater origin. The distribution of icy sediments and massive ice proximal to the limit of glaciation, the lack of massive ice within till, massive ice interlayered to depth with fluvial sands, the transition from massive ice to reticulate ice veins at some localities, vertically oriented strings of gas bubbles and matched broken soil fragments across ice lenses indicate an epigentic segregation origin for the ice. The ice likely formed from subglacial meltwater hydrostatically driven toward an aggrading permafrost table near the glacier margin.

3438 REDEKER, H.-J. and STÖFFLER, D. (1988)

The Allochthonous Polymict Breccia Layer of the Haughton Impact Crater, Devon Island, Canada; Meteoritics, Vol. 23, pp. 185-196.

The central allochthonous polymict breccia of the Haughton impact structure is up to about 90 m thick and as much as 7.3 km in radial extent. It has been analyzed with respect to modal composition, grain-size characteristics, and degree of shock metamorphism for the grain-size ranges 10-~50, 1-10, 0.03-1, and <0.03 mm. The mineralogy of the breccia matrix is dominated by

dolomite and calcite, with minor amounts of quartz, other silicate minerals, and rare melt particles. The following lithic clasts have been identified in the 1-10 mm size fraction (averages of vol.% given in parentheses); dolomitic rocks (51), limestones (29), crystalline rocks (10), sandstones and siltstones (3.7), chert (0.7), melt particles (1.9). The mineral clasts (1-0.03 mm) comprise (with decreasing frequency) dolomite, quartz, calcite, feldspar, biotite, amphibole, garnet, opaques, rounded quartz derived from sandstones and accessory minerals. Lithic and mineral clasts display various degrees of shock. Fragments of crystalline rocks are shocked in the 0-60 GPa range; whole rock melts from the crystalline basement are lacking and unshocked rocks are very rare. In contrast, shock-melted sandstones, shales, and chert were found in most samples. Large clasts of these melt rocks are highly concentrated near the center of the crater. Otherwise, no distinct change of the modal composition with radial range has been observed except that the frequency of limestone clasts increases slightly with radial range. The breccia near the center is more fine-grained than that beyond about 1 km radius and the sorting parameter increases somewhat with radial range. Except for the high concentration of shock-melted sedimentary rocks and highly shocked crystalline rocks near the center of the crater, the distribution of shock stages within the lithic clast population is quite uniform throughout the breccia formation. We conclude that the breccia constituents are derived from the lower part of the target stratigraphy (deeper than about 800 m) and that the total depth of excavation at Haughton is in the order of 2000 m. The mixing of sedimentary rocks of the Eleanor River Formation, Lower Ordovician, and Cambrian (~850 m thickness) with crystalline basement rocks is quite thorough and homogeneous throughout the breccia lens, at least for the analyzed part. This may require an air-borne mode of emplacement for the upper section of the breccia in analogy to the fall-back suevite in the Ries crater. A calculation of the excavation (Z-model) and of the shock pressure attenuation based on reasonable estimates of the energy and crater geometry of the Haughton impact confirms the observed maximum depth of excavation of about 2 km. Shock-melted crystalline basement rocks, if present at all, must be confined to the very center of the structure below the excavation cavity.

3439 RETELLE, M.J. (1985)

Stratigraphy and sedimentology of High Arctic coastal lake basins, northern Ellesmere Island, Northwest Territories; Abstract in 14th Arctic Workshop, Arctic Land-sea interaction, Nov. 6-8, 1985, pp. 88-89.

Sedimentary sequences contained in coastal lacustrine basins on northern Ellesmere Island offer a high resolution record of glacioisostatic uplift and climatic change during the Holocene.

3440 RETELLE, M.J. (1986)

Glacial geology and Quaternary marine stratigraphy of the Robeson Channel area, northeastern Ellesmere Island, Northwest Territories; Can. J. Earth Sci., Vol. 23, pp. 1001-1012.

Glacial and marine deposits associated with two phases of glaciation are exposed along a 60 km corridor on Ellesmere Island that borders Robeson Channel. The oldest sediments, tentatively dated at $\geq$70 000 BP, were deposited during a major advance of the northwest Greenland ice sheet across Robeson Channel. During subsequent retreat of this ice mass, glaciomarine sediments containing a High Arctic macro- and microfauna were deposited in the isostatic downwarp on Ellesmere Island. This marine unit was radiocarbon dated at 31 300 ± 900 and >32 000 BP; mean alle/Ile ratios are 0.218 ± 0.03 for the free fraction and 0.063 ± 0.011 for the total acid hydrolysate.

The last ice advance (late Wisconsin - early Holocene) did not extend into the field area from either interior Ellesmere Island or northwest Greenland. The ice-marginal sea transgressed to the marine limit (~116 m) and overlapped the deposits of the previous maximum Greenland advance. Local plateau ice caps did, however, spill over into one major valley and delayed the establishment of the marine limit in this location. Radiocarbon dates on the Holocene marine limit shorelines indicate initial emergence between 8000 and 8600 B.P. A mean alle/Ile ratio of 0.037 was found for the total acid hydrolysate; alle was undetectable in the free fraction of the Holocene shells.

The Holocene and pre-Holocene glacial and marine chronologies in the Robeson Channel area are similar to chronologies demonstrated from other locations in Arctic regions. Tentative correlations based upon aminostratigraphy suggest that the field area has remained, for the most part, ice free since at least 70 000 BP.

3441 RICHARDSON, R.J.H. (1987)

An Analysis of Coarse Glaciofluvial Sediments East Central Ellesmere Island, N.W.T.; Abstract in, Proc. 16th Arctic Workshop, Edmonton, Alberta, pp. 116-117.

The evolution of sediments from bedrock is complex. Variability in rock lithology, structure, types and intensity of erosional processes, often further complicated by long history, can be an overwhelming puzzle to decipher. To help establish the relative importance of physical bedrock characteristics and erosional processes, an area was selected for study in which a short and simple erosional history could be confidently assumed.

The bedrock in the Cape Herschel area has been mapped as massive to weakly gneissic orthopyroxene

granite. Similar rocks occur in the area but the local pink low hornblende granites can be easily recognized in the sediments. The bedrock is well jointed and controls the orientation of deep steep-walled valleys. Glaciofluvial meltwaters, capable of moving boulder size clasts, carved the valleys during major deglacial periods. The valleys have no catchment basin and are presently dry except for snow-melt runoff. Perched, coarse sediment, glaciofluvial deltas are preserved at the valley mouths.

The sedimentological study of very coarse material (-8 to -11 Phi) is difficult in Arctic regions. Bulk sampling is not usually practical since heavy equipment is not available and the sediments are permanently frozen. The areal sampling method was chosen for this study because it could be done in relatively small areas (related to clast size) and also because the exposed surfaces of all clasts are naturally marked by a lichen, thus eliminating the marking task. A modification of the method was employed where the ABC axis of all the large clasts (minimum B axis = 30 cm) in an area was measured (minimum of 100 clasts). All clasts with a B axis less than 30 cm and greater than 3 cm (A axis) within a sub-area were also measured (minimum of 100 clasts). A grab sample of finer material was collected for lab-sieving from a small sub-area. Problems in measuring axes of large boulders were less than anticipated, with only a few cases where recorded axis measurements are minima. The relative lack of fines, and thus freezing-in of clasts, is a result of the censored nature of the surface of what is likely a framework gravel.

Early results indicate that the sediments have undergone little transport and only subtle transport modification, sharing the same gross shape and size distribution as blocks of the local jointed bedrock. Future study will focus on quantifying the change of bedrock into sediment.

3442 RICKETTS, B.D. (1986)

New formations in the Eureka Sound Group, Canadian Arctic Islands; in Current Research, Part B, Geol. Surv. Can., Paper 86-1B, pp. 363-374.

The Eureka Sound Group, in eastern Arctic Islands, is divided into four new, lithologically distinct formations of regional extent. The oldest is the Expedition Formation of middle or late Campanian to early Paleocene age, consisting predominantly of sandstone and minor shale, that originated as wave dominated delta, barrier island and estuarine deposits; a major shale unit, the Strand Bay Formation of early to middle Paleocene age, that represents basin-wide marine transgression (early Paleocene), followed by regressive prodelta and shelf deposits; the Iceberg Bay Formation of middle or late Paleocene to middle Eocene age, consisting of fluvial sandstone and coal (mostly delta plain); and the stratigraphically highest unit, the Buchanan Lake Formation of middle Eocene age, possibly extending into the late Eocene, that consists of syntectonic conglomerate shed from adjacent thrust sheets, and signifying a major phase of the Eurekan Orogeny. Correlations are made with Eureka Sound strata on Bylot Island, Amund Ringnes Island, Lougheed Island, Banks Island and at Lake Hazen.

3443 RICKETTS, B.D. (1987)

Princess Margaret Arch: re-evaluation of an element of the Eurekan Orogen, Axel Heiberg Island, Arctic Archipelago; Can. J. Earth Sci., Vol. 24, No. 12, pp. 2499-2505.

It is argued on the basis of structural, stratigraphic, and sedimentologic criteria that Princess Margaret Arch developed during the principal phase of Eurekan thrusting and folding and therefore is no older than Middle Eocene. Sub-Eureka Sound Group unconformities on eastern Axel Heiberg Island are not associated with uplift on the eastern flank of this arch but are related to erosion of Mesozoic Sverdrup Basin strata over local evaporite diapir domes and ridges. Considerable disparity exists between levels of erosion on the flanks of the arch and the level of erosion along its axis, which cannot be explained by pre-Eocene uplift. Sedimentary facies and textural and petrographic characteristics of Eureka Sound Group strata do not reflect proximity to an arch. Palynomorph assemblages in the west-derived, syntectonic Buchanan Lake Formation (Middle Eocene) contain reworked latest Cretaceous spores and pollen that were derived from Eureka Sound Group strata originally located on or close to the arch axis.

Eureka Sound Group sedimentation in the Axel Heiberg Island - west Ellesmere Island region took place in a single, contiguous basin, rather than in smaller basins that were separated by ancestral Princess Margaret Arch.

3444 RICKETTS, B.D. (1987)

Preliminary structural cross-sections across Fosheim Peninsula and Axel Heiberg Island, Arctic Archipelago; in Current Research, Part A, Geol. Surv. Can., Paper 87-1A, pp. 369-374.

Partially balanced structure cross-sections have been drawn through the Eurekan orogen of west-central Ellesmere Island (Fosheim Peninsula) and central Axel Heiberg Island. Most of the horizontal shortening depicted in the cross-sections is taken up by slip along the Otto Fiord Formation detachment (evaporites); about 55 km (25-30%) of shortening occurs between Parrish Glacier Thrust and the hanging wall of the Stolz Fault Zone. A pair of ramps beneath Prince Margaret Range is inferred to explain the transfer of slip from an Ordovician detachment to the Otto Fiord detachment. The effect of Eurekan deformation on the lower Paleozoic Franklinian strata beneath Axel Heiberg Island and the northern half of Fosheim Peninsula is unknown.

3445 RICKETTS, B.D., and EMBRY, A.F. (1986)

Coal in the Canadian Arctic Archipelago: A potential resource; GEOS, E.M.&R., Vol. 15, No. 1, pp. 16-18.

Formed when the Arctic was much warmer than today, hardened by millions of years of compression and mild heating. The Canadian Arctic Archipelago, a region of ice, tundra and inclement weather, has not always been as inhospitable as many think of it today. Throughout its long geological history there have been several periods when much warmer and even tropical climates prevailed. Coal deposits formed during these periods are distributed over large areas of the Arctic Islands and provide a massive and as yet untapped source of fuel. EMR's Geological Survey of Canada is working to assess more accurately the potential of this resource.

3446 RICKETTS, B.D., and McINTYRE, D.J. (1986)

The Eureka Sound Group of eastern Axel Heiberg Island: new data on the Eurekan Orogeny; in Current Research, Part B, Geol. Surv. Can., Paper 86-1B, pp. 405-410.

The stratigraphy of Tertiary conglomerate, sandstone, mudstone and lignite beds, which outcrop over a wide area of eastern Axel Heiberg Island, is reassessed. The deposits are considered to be synorogenic on the basis of structure (overthrust by older Sverdrup Basin units in the Stolz Thrust zone), lithology and palynology. The deposits are correlated with thick synorogenic conglomerates at Mokka Fiord, and are included in the Buchanan Lake Formation of the Eureka Sound Group. The timing of synorogenic sedimentation can now be interpreted as Middle Eocene, on the basis of well preserved palynofloras. The deposits accumulated in the Axel Heiberg foredeep, which was one of a series of orogenic foredeeps that developed along eastern Axel Heiberg Island and eastern Ellesmere Island.

3166 RITCHIE, J.C. (1974)

Modern pollen assemblages near the arctic tree line, Mackenzie Delta region, Northwest Territories; Can. J. Bot., Vol. 52, pp. 381-396.

3167 RITCHIE, J.C. (1976)

The Campbell Dolomite Upland Near Inuvik, N.W.T. A Unique Scientific Resource; Musk-Ox, Vol. 18, pp. 70-75.

3168 RITCHIE, J.C. (1979)

Towards a Late-Quaternary Palaeoecology of the Ice-Free Corridor; Can. J. Anthropology, Vol. 1, pp. 15-28.

3169 RITCHIE, J.C. (1982)

The modern and Late-Quaternary vegetation of the Doll Creek area, North Yukon, Canada; New Phytol., Vol. 90, pp. 563-603.

3170 RITCHIE, J.C. (1984)

A Holocene pollen record of boreal forest history from the Travaillant Lake area, Lower Mackenzie River Basin; Can. J. Bot., Vol. 62, No. 7, pp. 1385-1392.

3171 RITCHIE, J.C. (1985)

Late-Quaternary climatic and vegetational change in the Lower Mackenzie Basin, Northwest Canada; Ecology, Vol. 66, No. 2, pp. 612-621.

3172 RITCHIE, J.C. (1987)

Comparaison entre la végétation du Mackenzie et du Nord Québécois à l'Holocène; Géographie physique et Quaternaire, Vol. XL1, N° 1, pp. 153-160.

3173 RITCHIE, J.C., and CWYNAR, L.C. (1982)

The Late Quaternary vegetation of the North Yukon; in Paleoecology of Beringia, Chapter 6, Academic Press Inc., New York, pp. 113-126.

3174 RITCHIE, J.C., HADDEN, K.A., and GAJEWSKI, K. (1987)

Modern pollen spectra from lakes in arctic western Canada; Can. J. Bot., Vol. 65, No. 8, pp. 1605-1613.

3447 ROBERTS, A.C., ANSELL, H.G., JONASSON, I.R., GRICE, J.D., and RAMIK, R.A. (1986)

Rapidcreekite, a new hydrated calcium sulfate-carbonate from the Rapid Creek area, Yukon Territory; Can. Mineralogist, Vol. 24, pp. 51-54.

Rapidcreekite, ideally $Ca_2(SO_4)(CO_3).4H_2O$, is a new secondary mineral species from the Rapid Creek area, northern Yukon Territory. It occurs on bedding planes and joint surfaces of a quartz-rich iron formation, as crystalline coatings and sprays of white to colorless acicular crystals. The symmetry is orthorhombic, space group Pcnb, with a 15.49(1), b 19.18(1), c 6.157(4), Å, a:b:c 0.808:1:0.321, Z = 8. Individual crystals have a maximum length of 2 mm and are elongate [001], with forms {010} broad and {100}, {001} minor.

The streak is white; lustre vitreous; brittle, fracture splintery; Mohs hardness 2; cleavage (010) perfect and (100) good; D (meas.) 2.21(1), D(calc.) 2.239 g/cm^3; nonfluorescent in ultraviolet light. Rapidcreekite is biaxial positive, α 1.516(1), β 1.518(1), γ 1.531(1), $2V_x$ (meas.) 45(3)°, $2V_x$(calc.) 43°, indicatrix orientation X = c, Y = a, Z = b. The strongest eight lines in the X-ray powder-diffraction pattern [d in Å(1)(hkl] are 7.78(100)(200), 4.31(70)(221), 3.88(70)(311,400,231), 3.11(80)(421,002), 2.917(50)(431), 2.797(60)(161), 2.555(50)(142,322) and 1.899(50)(303,580,233,082). Microprobe analyses and TGA-EGA gave CaO 36.3, SO_3 26.1, CO_2 14.0 and H_2O 23.6, sum 100.0 wt.%. The name refers to the general locality.

3448 ROBERTSON, P.B. (1988)

The Haughton Impact Structure, Devon Island, Canada: Setting and History of Investigations; Meteoritics, Vol. 23, pp. 181-184.

Although mapped initially as a piercement dome, subsequent discovery of shock metamorphism in clasts of an impact breccia, shatter cones in outcrops of uplifted target rocks and morphological and geophysical characteristics consistent with a complex crater, confirmed a meteorite impact origin for the Haughton structure, Devon Island.

Results of three field investigations carried out prior to 1984 defined a complex crater, 20 km in diameter, formed in a lower Paleozoic sedimentary sequence overlying gneisses of the Precambrian basement. The distribution of allochthonous breccia overlying the disturbed target rocks and of the sediments deposited in the crater-filling lake were mapped. A Miocene or possibly Holocene age for the crater was based on paleo-flora and fauna assemblages from the lake sediments. Gravity and magnetic surveys revealed anomalies coincident with the crater, but not interpretable from surface lithologies.

Some of the early investigations were of a reconnaissance nature and results and interpretation can only be considered preliminary. Other studies that were carried out in some detail, petrographic investigations in particular, require complementary work for a fuller understanding of their significance. As a result, in 1984 the HISS (Haughton Impact Structure Studies) group carried out a program of detailed geological mapping and sampling, and seismic, gravity, and magnetic surveys in an attempt to improve the definition of the surface and subsurface nature of Haughton, and to formulate a more complete understanding of its formation and subsequent history. Results of these various studies are presented in the eight succeeding papers of this volume.

3449 ROBERTSON, P.B., OSTERTAG, R., BISCHOFF, L., OSKIERSKI, W., NICKEY, L.J., and DAWSON, M.R. (1985)

First results of a multidisciplinary analysis of the Haughton Impact Crater, Devon Island, Canada. I Geology, Abstract in, Proc. XVI Lunar and Planetary Science Sym., Houston, Texas, pp. 702-703.

A large-scale investigation that included detailed geological mapping, seismic reflection, gravity and magnetic surveys was carried out at Haughton (75°22'N, 89°41'W) in the summer of 1984 and preliminary results of this program and subsequent laboratory investigations are reported in this volume. Haughton comprises a central basin with interior peaks, surrounded in succession by an inner ring of uplifted Paleozoic units, a faulted annulus of disrupted surface units, and a downfaulted outer margin. A possible middle ring in the faulted annulus, noted from analysis of topographic maps but not obvious in the field, gives rise to the suggestion that Haughton may be a multi-ring structure. Detailed structural mapping reveals that the outer margin of this ring shows outward dips whereas the inner slope is characterized by inward dips, and thus supports the proposal that this is indeed a structural ring. Uplifted Eleanor River limestones west of the basin center extend southward in an arcuate fashion from the prominent interior peak of the same lithology, and may represent an additional interior ring, largely masked by allochthonous breccia but continuous with interior peaks. The masked portions can be traced by a positive gravity anomaly resulting from the dense Eleanor River rocks. This ring coincides with the outer limit of shatter cones in situ.

3450 SCHAFER, C.T. (1988)

1987 Arctic Delta Failure Experiment (ADFEX) Field Program, Itirbilung Delta Survey, July 19 - August 1, 1987, Geol. Surv. Can., internal report, unpub. manuscript, 17 p.

As part of the Arctic Delta Failure Experiment (ADFEX) project, leading to the instrumentation and monitoring of an artificially-triggered submarine slide and turbidity current in September of 1988, personnel from the Norwegian Geotechnical Institute (NGI), the Department of Geology and Civil Engineering of Laval University (Lu), and the Environmental Marine Geology Subdivision of AGC (Geological Survey of Canada), participated in a survey of the sediments, shallow stratigraphy and foraminifera assemblages of the lower reaches of the outwash delta at the head of Itirbilung Fiord.

3451 SCHAFER, C.T., and BLAKENEY, C.P. (1984)

Baffin Island fjords; Sea Frontiers, Vol. 30, No. 2, pp. 94-105.

ON THE EAST COAST of Canada's Baffin Island, numerous fjords cut through the more than 1,500 million-year-old Canadian Shield, the remains of the oldest rocks underlying the continent. The fjords are pipelines for the transfer of coastal

climate, seawater, and a variety of marine life between the open sea and the shallow sheltered environments more than 60 miles inland.

3452 SCHAFER, C.T., and COLE, F.E. (1985)

Marginal marine foraminifera assemblages in three east coast Baffin Island fiords; Abstract in 14th Arctic Workshop, Arctic Land-sea interaction, Nov. 6-8, 1985, pp. 211-212.

A fall of 1983 survey in Cambridge, Itirbilung and McBeth fiords provided a suite of shallow water surficial sediment samples (launch samples) (100 m deep) and comparable material from deep, central basins (HUDSON samples) (100 m deep) that have been analyzed for the camoebians and benthonic foraminifera.

3453 SCHAFER, C.T., and COLE, F.E. (1986)

Reconnaissance Survey of Benthonic Foraminifera from Baffin Island Fiord Environments; Arctic, Vol. 39, No. 3, pp. 232-239.

Benthonic foraminiferal assemblages in 63 grab samples collected in Baffin Island fiord basin environments (67-800 m) are dominated by arenaceous species such as Textularia earlandi and Spiroplectammina biformis. These forms reflect the influence of cold (≤0.0°C) arctic water conditions. Incursions of comparatively warm and saline Atlantic bottom water is marked in the deepest part of some fiord basins by the distribution of several calcareous species such as Melonis zaandamae and Nonionella atlantica. The highest living calcareous species population densities are associated primarily with fiord sills and with inner shelf environments near the mouths of fiords. Conversely, the patchy distribution and low percentages of many calcareous species found in basin sediments suggest passive transport of perhaps both living specimens and empty tests from shallow nearshore (endemic) environments or their occupation of deep basin transitional environments that mark the change from Atlantic to arctic water masses.

3454 SCHOCH, R.M. (1987)

Fossils from the Canadian High Arctic; Fossils Quarterly, Spring 1987, pp. 18-30.

The High Arctic was not always what it is today. Fifteen million years ago, during the middle Miocene, the Arctic was populated by rhinoceroses and tragulids (chevrotains or mouse deer) living in birch and conifer forests. During the Paleocene and Eocene epochs (45 to 65 millions years ago) the present-day Arctic was an area of swampy lowlands, quiet rivers and towering forests consisting of the dawn redwood (Metasequoia), ancestral hickories, birches, elms, sycamores, maples, and the kadsura tree (Cercidiphyllum). Ferns and herbaceous flowing plants grew in more open areas and horsetail rush (Equisetum) grew along the channels and stream banks. Along with this lush vegetation lived primitive fishes (holosteans), amphibians such as salamanders and newts, turtles, lizards, crocodiles, birds (including the giant Diatryma) and a large mammalian fauna composed of multi-tuberculates, insectivores, numerous species of flying lemurs (dermopterans), primitive prosimian-like primates, rodents, tillodonts, pantodonts (Coryphodon), creodonts, early carnivores, and several early perissodactyls (hyrachids and brontotheres).

3455 SCHRÖDER, C.J., MEDIOLI, F.S., and COLE, F.E. (1988)

Benthic foraminifera of Arctic environments: ice island versus Lancaster Sound; Abstract in, GAC, MAC, CSPG Joint Annual Meeting, May 23-25, 1988, St. John's, Newfoundland, Program with Abstracts, Vol. 13, pp. A109-A110.

Surface sampling and high resolution seismics resulted in the discovery of glass sponge reefs on the Western Axel Heiberg Shelf. These reefs form a habitat for a unique benthic fauna. Benthic foraminifera are abundant, highly diverse, and predominantly calcareous. One hundred and ten species, including 38 agglutinated taxa, were identified in 47 surface samples. Living specimens are scarce with less than 3% indicating a residual fauna. Important influencing environmental parameters are a perennial ice cover which causes the formation of cold dense brines, a low sedimentation rate and a limited supply of food. The use of niches with sufficient nutrient supply results in a patchy distribution of benthic foraminifera on a small scale.

The foraminiferal assemblage of Lancaster Sound differs from the Ice Island assemblage by being less diverse, dominated by agglutinated species and showing an abundant living component. The seasonal ice-cover, input of melt-water, lower salinity, and higher sedimentation rate are of prime importance to the distribution of benthic foraminifera.

3456 SCOATES, R.F.J., JEFFERSON, C.W., and FINDLAY, D.C. (1986)

Northern Canada mineral resource assessment; in Prospects for mineral resource assessments on public lands; Proc. Leesburg Workshop, U.S. Geol. Surv., Circular 980, pp. 111-139.

Assessment of Canadian mineral resources began in the 1950's and took the form of national commodity estimates conducted in response to national and international requests. Northern mineral resource assessments have been performed in response to requests from other government agencies and have most frequently been related to native peoples land claim negotiations and to the proposed establishment of northern national parks. The northern mineral and energy resource assessment process is coordinated and administered by two

Federal Government interdepartmental committees established in 1980, and the assessments themselves are performed by the Geological Survey of Canada (GSC).

Northern resource assessments consist of two phases. Phase 1 is basically paper research and phase 2 includes, in addition, on-site geologic examination. The assessment process includes (1) definition of the study area, (2) compilation of geology from existing sources and establishment of geologic domains, (3) inventory and appraisal of mineral and energy resources in the study area, and (4) application of conceptual deposit models to the study area followed by qualitative assessment.

Banks Island, where two park areas are proposed, is an example of a current GSC resource assessment study. The study area includes all of Banks Island and the western part of Victoria Island. One of the geologic domains present comprises late Proterozoic platformal strata, basalts and related sills to which a volcanic red bed copper deposit model has been applied. Disseminated native copper and copper sulfide veins are known to occur in the basalts, although economic deposits have yet to be found. No major differences are apparent between attributes of the deposit model and those of the geologic domain. The rating for the occurrence of undiscovered red bed copper deposit type is therefore high. Similarly, the sandstone-hosted uranium deposit model applied to Cretaceous sandstones has been applied to another domain.

The need for periodic reassessment of previously assessed areas can be evaluated by using an historically based resource assessment matrix. The two-dimensional matrix consists of metal commodities plotted along one axis and time plotted along the other axis. An area in southeastern Manitoba that possesses a well-documented exploration and mining history has been chosen to illustrate the matrix. The historically based resource assessment matrix illustrates the importance of time in terms of changing potential ratings for commodities as well as in terms of increasing confidence levels for commodity ratings, regardless of whether the ratings themselves change with time.

3457 SCOTT, D., and HAJNAL, Z. (1988)

Seismic Signature of the Haughton Structure; Meteoritics, Vol. 23, pp. 239-247.

The western flank of the Haughton impact structure was imaged with a reflection profile generating 9.8 km of subsurface information. Ten reflecting horizons were recognized and have been correlated via a sonic log with the Paleozoic limestone/dolomite rock sequences. The seismic section is dominated by a dense and complex compound fault system with variable attitudes. These steeply dipping faults penetrated the sedimentary rocks but showed no recognizable extension into the crystalline basement. According to the seismically recognized fracture zones of the western margin, the structure is significantly larger than previously estimated. Reconstruction of the crater on the basis of the seismic information and existing scaling relationships reveals a structure with an apparent diameter of 23.9 km, and an excavated cavity of 10.3 km width and 1.97 km depth. The estimated diameters of the transient crater and the central uplift are 12 km and 11 km respectively. The morphologically distinct ring zones do not have seismically recognizable subsurface signatures. The underlying crystalline basement rocks did not exhibit seismically mappable impact-related zones of disturbance. In the central interior region, coherent reflection signals are virtually absent. Valuable information for this area was provided by a 10.26 km long refraction profile that indicated nearly uniform velocities (~5000 m/s) to a considerable depth. Major lateral variations in the velocity field across the structure were not detected.

3458 SEATON, J.B. (1983)

Slave Structural Province; in Mineral Industry Report 1978, Northwest Territories, Chapter VII, Indian & Northern Affairs, Yellowknife, N.W.T., EGS-1983-2, pp. 109-126.

3459 SEATON, J.B. (1984)

Slave Structural Province; in Mineral Industry Report 1980/81, Northwest Territories, Chapter 7, eds. J.A. Brophy and C.E. Ellis, Indian & Northern Affairs, Yellowknife, N.W.T., EGS-1984-5, pp. 333-408.

3460 SEATON, J.B., and CRUX, J.C. (1985)

Slave Structural Province; in Mineral Industry Report 1982-83, Northwest Territories, Chapter 8, ed. J.A. Brophy, Indian & Northern Affairs, Yellowknife, N.W.T., EGS-1985-4, pp. 287-361.

3461 SHARPE, D. (1985)

Glaciomarine sedimentation on Southern Victoria Island, N.W.T., Abstract in 14th Arctic Workshop, Arctic Land-sea interaction, Nov. 6-8, 1985, p. 109.

Geological mapping of Late Quaternary sediments on Victoria Island, N.W.T. has provided data on the distribution and nature of glaciomarine sediments. Most of the sediment is proximal to source, that is, ice-marginal in nature. Very little sediment has been deposited far from the ice-contact environment unless it has been transported into deeper oceans basins beyond present uplifted land surfaces. These findings are indicated by rapid areal facies changes within outwash-glaciomarine delta systems and within subaqueous fan deposits. Many lateral moraines are predominantly composed of subaqueous deposits produced by sediment gravity flow mechanisms. These deposits show

abrupt lateral facies transitions from massive diamictons to graded sand sequences over short intervals. The results of studies attempting to understand the processes of glaciomarine sedimentation at tidewater glaciers has improved the above interpretations.

3462 SHARPE, D.R. (1988)

Late Glacial landforms of Wollaston Peninsula, Victoria Island, Northwest Territories: product of ice-marginal retreat, surge, and mass stagnation; Can. J. Earth Sci., Vol. 25, pp. 262-279.

An analysis of glacial landforms on a regional scale leads to an interpretation of the dynamics of Late Wisconsinan glaciation on Wollaston Peninsula, Victoria Island, Northwest Territories. The glacial record is dominated by four adjacent belts of landforms: (I) ground moraine (till plains and ice-marginal drainage features, (II) hummocky moraine, (III) lateral and shear moraine, and (IV) streamlined landforms. The landform belts are considered as representing four distinct glacial ice conditions or regimes: (1) ice-margin retreat during extending flow of thin, active ice; (2) marginal ice stagnation following compressional flow; (3) a surging ice margin producing massive shear moraines; and (4) large-scale flooding and mass ice stagnation following a surge. These landform belts were arranged in zones by topographically controlled glacial dynamics, the latter two defining a former ice stream.

Glaciological inferences can be extended by examining the sediments and processes that produced each landform set. Ground-moraine sediments were produced mainly subglacially from melt out or lodgment of glacial debris. Hummocky moraine resulted from debris flow and meltwater deposition controlled by ice, from resedimentation by sediment gravity flow, and from slump. Compressional shearing stacked thick deposits of drift prior to resedimentation. Simple lateral or end moraines may comprise interbedded sediment gravity flows deposited at static ice margins. Deformed lateral moraines resulted from intense marginal compressive flow that sheared and stacked thick, coarse sediment ridges or plates. This lateral shearing may be attributed to streaming or large ice surges. Drumlin exposures showed undeformed, interbedded, stratified sediments that appear to have accumulated in a subglacial cavity; there is no deformation related to high subglacial stress. Subglacial meltwater floods may have followed glacier surge. The greatly extended and thinner ice mass produced by the surge melted in place as clean (debris-free) ice.

3230 SHIMIZU, O. (1985)

Topographical change caused by thermal erosion of a massive ground ice body in Tuktoyaktuk, N.W.T., Canada; in Characteristics of the Massive Ground Ice Body in the Western Canadian Arctic Related to Paleoclimatology 1984-1985, ed. K. Fujino, Inst. Low Temp. Science, Hokkaido Univ., Japan, pp. 71-85.

3463 SOBCZAK, L.W., MAYR, U., and SWEENEY, J.F. (1986)

Crustal section across the polar continent - ocean transition in Canada; Can. J. Earth Sci., Vol. 23, No. 5, pp. 608-621.

The Canadian Arctic Transect extends northwards from the Canadian Shield across a thick (about 18 km) and wide (over 800 km) sedimentary section consisting of four overlapping basis. These overlie a continental crystalline crust that thins from 48 to 8 km towards the Canada Basin. The latter overlies a relatively thin (5-10 km thick) oceanic crust below the Arctic Ocean. The calculated gravity effects of the upper sedimentary section were stripped away from the observed gravity anomaly, and the residual anomalies were used to determine the boundaries between sediment and crystalline crust and between crust and mantle. Residual anomalies with short wavelength and steep gradients were used to modify the initial near-surface structural model and to identify zones of evaporite and mafic rocks within the sedimentary rock column.

Some interesting results emerge from this analysis: (1) analysis of the gradients of the shelf and slope suggests that shelf subsidence is hinged about a line near the central axis of the Sverdrup Basin; (2) continental crystalline crust thins oceanward from 48 km to 8 km at the transition zone over a distance of 825 km and appears to have stretched from an original width of 543 km, for an apparent stretch factor of about 1.5; (3) sediment thickness is usually inversely related to the crystalline crustal thickness; (4) the mantle below the ocean appears to be less dense than below the continental crust, with an assumed significant vertical density boundary between the two below the continental shelf (transition zone); (5) this analysis supports the concept that evaporites occur along the axis of the Sverdrup Basin, and mafic rocks appear to be concentrated along the flanks of the Sverdrup Basin; and (6) seismicity usually occurs over areas of relatively positive gravity anomalies that are considered to be the result of uncompensated sedimentary loads or mafic igneous intrusions or are areas of uplifted and folded rocks.

3464 SONNICHSEN, G.V., and ATKINSON, A. (1987)

A small boat survey of the Lougheed - King Christian - Cameron Islands Region of the northwestern Canadian Arctic using open water leads; Geol. Surv. Can., Open File No. 1903, Report of Field Activities, AGC Program No. 87-100, 23 p.

Since 1984, the Atlantic Geoscience Centre (AGC) of the Geological Survey of Canada has undertaken a series of investigations of the Quaternary sediments of the Arctic Island Channels as part of

the Northern Oil and Gas Action Program (NOGAP). Objectives are to determine the geological and geotechnical properties, and regional character and history of the unconsolidated sediments, and to identify geological constraints to future subsea engineering for production facilities and transportation of hydrocarbons in inter-island channels.

In 1986, the ice-covered channels surrounding Lougheed Island were investigated using an experimental technique in which a 5 metre inflatable boat was transported by helicopter to open water leads to collect continuous seismic reflection profiles. Cores, grab samples and/or bottom photographs were also collected at four sites along the leads. This program obtained reconnaissance information in the channels south and west of Lougheed Island.

In 1987, the same technique, with modifications to both procedure and equipment, was used to collect reflection profiles (sparker, Datasonics Bubblepulser, and 12 kHz) and bottom samples in the Lougheed - King Christian - Cameron islands region. This report describes the 1987 program and its results.

3465 SONNICHSEN, G.V., and VILKS, G. (1987)

A small boat seismic reflection survey of the Lougheed Island Basin - Cameron Island Rise - Desbarats Strait region of the Arctic Island channels using open water leads; in Current Research, Part A, Geol. Surv. Can., Paper 87-1A, pp. 871-882.

Lougheed Island Basin, Desbarats Strait, and Cameron Island Rise in the Arctic Island channels were geologically examined using helicopter-transported inflatable boats in open water leads through the near permanent ice cover. This experimental technique has allowed collection of the first continuous seismic reflection data in the region, as well as gravity cores and bottom photographs at four stations. Three stratigraphic units are identified from the seismic profiles; a lowermost unstratified sediment whose surface has irregular relief and variable thickness to 53 m, interpreted to be glacial drift; a localized stratified unit which reaches 10 m in thickness and overlies the drift; an uppermost ponded acoustically transparent mud which varies from 1 to 4 m in thickness and occurs in depths greater than 150 m.

3466 STEPHENSON, R.A., RICKETTS, B.D., BOYD, J.B., and LOSIER, I. (1988)

Geological interpretation of new gravity data from northern Axel Heiberg and northwestern Ellesmere Islands, Canadian Arctic Archipelago; Abstract in, GAC, MAC, CSPG Joint Annual Meeting, May 23-25, 1988, St. John's, Newfoundland, Program with Abstracts, Vol. 13, p. A117.

During the summer of 1987, the Geological Survey of Canada occupied approximately 700 new gravity stations (with station spacing of about 10 km) in a regional gravity survey of northern Axel Heiberg and northwestern Ellesmere Islands in the Canadian Arctic Archipelago. Included were 320 km of more detailed gravity transects with station spacings of about 2 km. The topography of the survey area is rugged; vertical positioning of gravity stations was provided by a helicopter-mounted Inertial Navigation System and the gravity data have been regionally terrain corrected using a 1:250 000 digital terrain model of the area.

The survey area is floored by crystalline continental crust overlain by lower Paleozoic sedimentary strata of the Franklinian Geosyncline, deformed and metamorphosed during the middle to late Paleozoic Ellesmerian Orogeny, and in turn, overlain by upper Paleozoic through Tertiary sedimentary and volcanic strata of the pericratonic Sverdrup Basin, uplifted and deformed during the Early Tertiary Eurekan Orogeny.

A significant horizontal gravity gradient, associated with the Eurekan Stolz Thrust on eastern Axel Heiberg Island, is related to basic intrusive rocks interlayered with Sverdrup Basin strata and stacked in the hanging wall, placing limits on the geometry of the fault at depth and on the extent to which the sedimentary strata have been intruded. Dominant gravity lows lie along the western flank of Axel Heiberg Island and, together with the high associated with the hanging wall of the Stolz Thrust, tend to refute the postulation that the Eurekan Princess Margaret Arch, running along the axis of Axel Heiberg Island, is structurally similar to the central Sverdrup Basin Cornwall Arch, the latter being associated with a previously known prominent positive gravity anomaly suggestive of basement and/or crustal involvement. A prominent regional positive gravity anomaly is centred on Kleybolte Peninsula (Ellesmere Island) at the northern end of Nansen Sound, near the edge of the autochthonous terrain of the Ellesmerian Orogen, in an area where ultramafic rocks are known to outcrop.

3467 STEPHENSON, R.A., ZELT, B.C., and LANE, L.S. ASUDEN, I., FORSYTH, D.A., SPENCER, C., and ELLIS, R.M. (1988)

Crustal structure from regional seismic refraction data in the Mackenzie Delta - Beaufort Sea - Northern Yukon area; Abstract in, Proc. GAC, MAC, CSPG, Joint Annual Meeting, May 23-25, 1988, St. John's, Newfoundland, Program with Abstracts, Vol. 13, pp. A117-A118.

A regional seismic refraction survey was conducted by the Geological Survey of Canada in March 1987 in the Mackenzie Delta - southern Beaufort Sea - northern Yukon area and resulted in the acquisition of approximately 830 km of reversed, 110 km of unreversed, and 650 km of broadside seismic profiling along three lines. Recorder spacing averaged 3 km. Shots were detonated from six sites on land and four sites offshore.

Preliminary models based primarily on two-dimensional travel-time analysis of the seismic refraction data are presented, including those for Line F of the refraction survey, a line that runs northwesterly along the eastern flank of the Mackenzie Delta from the Peel Plateau in the south to a latitude of 70.4°N in the Beaufort Sea where the water depth is approximately 400 m. The modelling and interpretation of more than half of Line F is facilitated by a nearly coincident regional 16-second seismic reflection profile recorded by the Geological Survey of Canada in 1986. The refraction results show a decrease in upper and lower crustal velocities from the area of the Peel Plateau and Campbell Uplift south of the Mackenzie Delta across the Eskimo Lakes Fault Zone to the area beneath the thick ?Upper Jurassic-Tertiary Beaufort-Mackenzie sedimentary basin. They are consistent with the suggestion that the southern edge of the present Beaufort-Mackenzie Basin is coincident with a ?Proterozoic-early Paleozoic continental margin and that the Mackenzie Delta in this area is ultimately underlain by ?Proterozoic -early Paleozoic transitional or oceanic crust. The thickness of the ?Upper Jurassic-Tertiary succession in this area is approximately 12 km. Near the northern end of Line F this succession appears to remain thicker than 10 km and is underlain by a 10-15 km thick layer that may be transitional or oceanic crust associated with the present day Arctic Ocean. Moderately rapid shallowing of the Mohorovicic discontinuity occurs within about 100 km north of the Eskimo Lakes Fault Zone. The crustal models based on the seismic refraction and reflection data are shown to be consistent with gravity anomalies observed along the profile.

3113 STEWART, T.G., and ENGLAND, J. (1986)

An early Holocene caribou antler from northern Ellesmere Island, Canadian Arctic Archipelago; Boreas, Vol. 15, pp. 25-31.

3468 ST-ONGE, D.A. (1987)

Morphosedimentary zones and Wisconsinan glacial limit, Bluenose Lake Region, N.W.T., Abstract in GAC-MAC Joint Annual Meeting, Univ. Saskatchewan, May 25-27, 1987, Program with Abstracts, Vol. 12, p. 92.

Using landforms and dominant sediment types, the Bluenose Lake area, in the northern District of Mackenzie, south of Dolphin and Union Strait, has been divided into six morphosedimentary zones: A, Felsenmeer, kame and silt mounds complex; B, Bluenose Lake Moraine complex; C, Inman River drumlin field; D, Upper Harding River moraine complex; E, Rae River glacial lakes sequence; F, Marine offlap area. Systematic mapping north of 68° to the coast and between 116°30' and 120°W shows that these distinct zones represent dynamic zonation within terminal areas of the Late Wisconsinan ice sheet. The boundary between the drumlin field and end moraine was previously interpreted as the Late Wisconsinan glacial limit while the distal side of the end moraine itself was taken as the Early Wisconsinan limit. Field evidence in the Bluenose Lake area does not support this view; results suggest that Late Wisconsinan ice reached elevations of app. 600 m a.s.l. This, in turn, suggests that this ice mass covered most of Victoria Island and may have extended westward to rest against the east and south coast of Banks Island as portrayed on the Glacial Map of Canada.

3469 ST-ONGE, D.A., and McMARTIN, I. (1987)

Morphosedimentary zones in the Bluenose Lake region, District of Mackenzie; in Current Research, Part A, Geol. Surv. Can., Paper 87-1A, pp. 89-100.

Using landforms and dominant sediment types, the Bluenose Lake area, northern District of Mackenzie, has been divided into six morphosedimentary zones: A, Felsenmeer, kames, and silt mounds complex; B, Bluenose Lake moraine complex; C, Inman River drumlin field; D, Upper Harding River moraine complex; E, Rae River glacial lakes sequence; F, Marine offlap area. Systematic mapping north of 68°N to the coast and between 116°30' and 120°W shows that each of these distinct zones was defined mostly by the nature and activity of glacier ice. Zone A was covered by a thin layer of ice but not modified by glacial movement; it marks the limit of Wisconsinan ice advance in this area. Zone B was an area of massive deposition of glacial, glaciofluvial, and glaciolacustrine sediments at the margin of an active ice mass. Zone C, composed of long drumlins on flat-lying dolomite bedrock, reflects active ice flow from the south-southeast between the Bluenose Lake moraine complex and the morainic complex in the upper reaches of Harding River. Zone D is defined by sinuous morainic ridges with extensive areas of boulder fields and hummocky till; the ridges indicate complex lobation at the margin of the retreating ice mass. Zone E is an area of washed till, beach ridges, and at lower elevations, sandy silt and clay rhythmites. These features record the presence, during early deglaciation, of a sequence of overlapping lakes marginal to an ice lobe in the basin of the Rae and Richardson rivers. Zone F is that part of the coast that was covered by the postglacial sea; the limit of submergence varied from approximately 45 m a.s.l. to 120 m a.s.l.

3121 SUTCLIFFE, A.J. (1985)

On the track of Ice Age mammals; British Museum (Natural History), London, England, Henry Ling Ltd. publisher, Dorchester, Dorset, 224 p.

3185 SWEENEY, J.F., and WEBER, J.R. (1986)

Progress in understanding the age and origin of the Alpha Ridge, Arctic Ocean; J. Geodynamics, Vol. 6, pp. 237-244, CESAR Contr. No. 29.

3470 SYVITSKI, J.P.M. (1985)

The influence of sea-level fluctuations, discharge variations and sea conditions on Arctic delta formation: examples from Baffin Island; Abstract in 14th Arctic Workshop, Arctic Land-sea interaction, Nov. 6-8, 1985, pp. 145-147.

Deltaic sediment deposits along the coast of Baffin Island are mostly Quaternary in age. They lie unconformably over a Proterozoic basement. However, in the Salmon River delta (N.E. Baffin Island), the Quaternary sediments lie disconformably over well-sorted and mostly unlithified Tertiary deltaic sediments. Such a relationship may also exist for other foreland deltas (such as the Cape Aston delta).

3471 SYVITSKI, J.P.M. (1985)

Subaqueous slope failures within seismically active Arctic fjords; Abstract in 14th Arctic Workshop, Arctic Land-sea interaction, Nov. 6-8, 1985, pp. 60-63.

Ten fjords along the coast of Baffin Island were surveyed from surface vessels and submersibles, in 1982, 1983 and 1985. The fjords were chosen to cross a number of environmental gradients, including seismic activity. Sunneshine Fiord (66°30'N) fell within a low risk earthquake zone (horizontal accelerations of <0.08 g). Probability of high ground accelerations increase to the north and Tingin, Itirbilung, McBeth, Inugsuin, Clark and Cambridge (71°30'N) fjords all fall within one of the most seismically active areas of Canada (g_h >0.3 g). Historic earthquakes greater than Richter 7.2 magnitude have been recorded in this region (Earth Physics Branch, Canada, data).

Acoustic data, from high-resolution sidescan and seismic reflection profiles, and lithologic data, from grab samples, piston and Lehigh cores, both indicate that subaqueous failures are common in all ten fjords. Areas of failure can be divided into three zones: (1) along the actively prograding fjord-head prodelta slopes, seaward of both sandurs and tidewater glaciers; (2) along the steep side-wall slopes, including off side-entry deltas, tidewater glaciers and junctions with submerged hanging valleys; and (3) on submerged sills (frontal dump moraine, kame delta, sediment mantled bedrock). Sediment some 50 to 100 m beneath the seafloor may also be folded or faulted but these features mostly appear separate from the surface failure events.

3472 SYVITSKI, J.P.M., and SCHAFER, C.T. (1985)

Sedimentology of Arctic Fiords Experiment (SAFE): Project Introduction; Arctic, Vol. 38, No. 4, pp. 264-270.

The Geological Survey of Canada's project SAFE (Sedimentology of Arctic Fiords Experiment) was initiated in 1981 and is being carried out in a series of fiords situated along the east coast of Baffin Island. SAFE emphasizes the study of the Quaternary history and modern processes of arctic fiord environments. Project participants are interested in evaluating the significance of the comparatively rapid process rates and of the high-resolution sedimentary records that typify these settings.

The key objectives of SAFE include: (1) to understand sandur development and the character of the resultant facies; (2) to understand the time-dependent influences of rivers, tides, waves, wind and deep-water renewal on fiord circulation and sedimentation patterns; (3) to use the geological record of raised marine deposits in establishing late Quaternary history within and between fiords.

Following a reconnaissance of 10 fiords along the east coast of Baffin Island in 1982, 3 were selected for detailed study during the 1983 field season (Cambridge, Itirbilung, McBeth). The 1982 and 1983 investigations utilized the oceanographic research vessel CSS Hudson as an operations base. During both surveys, core sampling, CTD profiling, geophysical mapping and other heavy work were carried out from the Hudson up to the 100 m isobath. The shallow water operation was supported by two launches outfitted with equipment to carry the oceanographic and geological programs into nearshore uncharted areas. Field parties were landed to study raised marine deposits and glacial features. The 1983 survey was preceded by a helicopter-supported program that succeeded in mooring and recovering several strings of current meters and sediment traps near the heads of Cambridge and Itirbilung fiords.

3473 TAUXE, L., and CLARK, D.R. (1987)

New paleomagnetic results from the Eureka Sound Group: Implications for the age of early Tertiary Arctic biota; Geol. Soc. America Bull., Vol. 99, pp. 739-747.

Some 300 specimens from 101 sites were analyzed from sections spanning more than 2,000 m of lignitic carbonate and clastic rocks. The sediments belong to the lower Tertiary Eureka Sound Group and are exposed near Bay and Strathcona Fiords on Ellesmere Island. Paleomagnetic analysis suggests that remanence is carried by magnetite, and positive fold and reversals tests support an early (detrital or early post-depositional) acquisition of the characteristic magnetization. We correlate the local magnetostratigraphy to Chrons C25 and C26 of the time scale.

Comparison of the magnetostratigraphic results obtained here with results from Paleocene/Eocene sections from Wyoming and Texas do not support a significant temporal discrepancy of faunal and floral assemblages between the Arctic and the southwestern United States.

3474 TAYLOR, R.B. (1987)

Coastal surveys in the Central Queen Elizabeth Islands (Dundas, Devon, Somerset, Cameron, and Lowther Islands, (NWT); Geol. Surv. Can., Open File No. 1595, AGC Cruise Report 86303, 45 p.

Twenty-five beach stations were examined during helicopter operations from CSS Hudson (cruise 86027) from August 25 to September 16, 1986. A 10-year comparison between 1976 and 1986 beach surveys indicated a net vertical degradation of less than 0.5 m at most of the 18 profiles resurveyed. Many of the profiles exhibited a partial rebuilding in the form of new swash ridges, but none of these new features exceeded the elevation of the 1976 storm ridges. The greatest changes were recorded at Cape Ricketts, Devon Island where as much as 11 m of recession occurred to the northwest of the Cape and a new 1.2 m high storm ridge formed at the end of the Cape. Survey evidence further suggests that the beaches were reworked by waves more since 1981 than during the first 5 years after 1976.

At two locations on Lowther Island and one on Sheills Peninsula, northwest Devon Island, surveys were extended across the raised beach sequence to elevations of 17 to 25 m asl. Vertical spacing of the beach ridges was 0.9-1.9 m and horizontal spacing varied from 14-29 m. The largest ridges of 1.8 m amplitude were formed across marine benches or at distinct breaks in topographic slope. The smallest and closest spaced ridges occurred on western Lowther Island which has a steeper inherent slope and experiences very limited wave activity. Since 1969 when our beach surveys began, no new beach ridges, comparable in size to those on the emergent coast, have been observed with the single exception of the new ridge at Cape Ricketts. Using radiocarbon dates of material from raised beach sequences near our survey sites, the average time span required to develop a primary beach ridge is estimated to be 275 years on northwest Devon Island and 225-300 years on Lowther Island. This is considerably longer than the 45 year cycle previously reported in the literature.

Aerial video surveys of the southeast coast of Melville Island and western Byam Martin Island provided information on shore and nearshore morphology and sediment character, as well as the locations of severe sea ice ridging and shore ice override in 1986.

3475 TAYLOR, R.B., and FORBES, D.L. (1987)

Ice-dominated shores of Lougheed Island: type examples for the northwest Queen Elizabeth Islands, Arctic Canada; in Proc. Canadian Coastal Conference, ed. Y. Ouellet, Nat. Res. Council, Assoc. Committee for Research on Shoreline Erosion and Sedimentation (ACROSES), July 7-10, 1987, Québec, pp. 33-48.

The low, mainly cohesive, microtidal shores of Lougheed Island are divided into four main coastal types (sandflat, mudflat, scarred and deltaic) which are presented as type examples of Holocene coastal development in the northwest Queen Elizabeth Islands. These shores belong to the extreme lower end of the coastal wave-energy spectrum. Shore-zone morphology and sediments of the first three coastal types reflect the dominance of sea-ice and terrestial processes. Regressive sedimentary facies sequences expected to be preserved beneath the emerged shores of this region are suggested on the basis of a comparison of equivalent across-shore and ice-built sedimentary facies observed beneath the three coastal types on Lougheed Island.

3476 TELLA, S., and ANNESLEY, I.R. (1987)

Precambrian geology of parts of Chesterfield Inlet map area, District of Keewatin; in Current Research, Part A, Geol. Surv. Can., Paper 87-1A, pp. 25-36.

The central part of the map area is underlain by ?Archean lithologies dominated by polydeformed orthogneiss, migmatite and weakly deformed granitoid plutons, and to a lesser extent by pelitic gneiss, amphibolite and banded quartz-magnetite iron-formation. To the south, a 15-km-wide west-northwest-trending and south-dipping paragneiss belt, consisting of garnet-biotite + staurolite + kyanite ± sillimanite + muscovite assemblages, overlies the central gneiss region. Two-pyroxene granulites occur to the northeast, north of the settlement of Chesterfield Inlet. An apparent increase in metamorphic grade from amphibolite to granulite facies occurs from south to north, and a tilted structural cross-section with progressively deeper-crustal levels towards the north, is exposed in the Chesterfield Inlet region. The age of metamorphism and deformation is considered to be Archean.

An approximately 5-km-wide, ENE-trending ductile shear zone occurs within the gneiss terrane north of Chesterfield Inlet. Asymmetrical pull-apart structures, and ENE-trending pervasive mineral-stretching lineations within the shear zone suggest shallow oblique, dextral displacement of unknown magnitude.

3477 TELLA, S., and ANNESLEY, I.R. (1988)

Hanbury Island shear zone - a deformed remnant of a ductile thrust, District of Keewatin, N.W.T., Abstract in, Proc. GAC, MAC, CSPG Joint Annual meeting, May 23-25, 1988, St. John's, Newfoundland, Program with Abstracts, Vol. 13, p. A124.

The Hanbury Island Shear Zone (HISZ) is a NE trending, synformal structure formed under amphibolite to granulite facies that overlies a lower grade granitoid gneiss terrane, and is well exposed along the northwestern shore of Hudson Bay northeast of Chesterfield Inlet. It has an exposed strike length of 40 km and a width of 5 km. Mylonitic rocks characterize the HISZ. The mylonitic layering contains disrupted and boudinaged mafic and quartzofeldspathic layers, and heterogeneously strained coronitic gabbro and anorthosite - all of uncertain age. A penetrative, subhorizontal to shallow (10°-30°) ENE plunging mineral stretching lineation is well developed within the zone. Most pull-apart structures exhibit layer parallel extension, but a few asymmetrical pull-aparts in mafic layers, and asymmetrical drag folds show both sinistral and dextral senses of shear. Although the contrasting senses of shear may be explained by the folded nature of the shear zone the direction of tectonic transport is not clear (NE or SW?). The zone is believed to be an integral part of a number of ductile high-strain zones associated with the uplift of granulite-anorthosite complexes exposed between Baker Lake and Daly Bay, and is tentatively interpreted as a deformed remnant of a late Archean or early Proterozoic, (NE or SW directed) ductile thrust.

3478 THORSTEINSSON, R., and MAYR, U. (1987)

The sedimentary rocks of Devon Island, Canadian Arctic Archipelago; Geol. Surv. Can., Memoir 411, 183 p.

The present study deals mainly with the stratigraphy, structural geology and environment of deposition of the strata of the Arctic Platform, comprising mainly a structurally concordant succession of lower Paleozoic strata in the western three quarters of the island. The Paleozoic strata comprise, for the most part, a westerly dipping homocline.

The greater part of the sedimentary column, in terms of age span and volume of sediments, is made up of Lower Cambrian to Lower Devonian strata. However, strata of Proterozoic, Mesozoic and Cenozoic ages are represented also. The column is divisible into three structurally conformable successions that are separated from one another by regional unconformities, and a fourth succession that includes two unnamed formations in the Haughton impact crater: (1) the Proterozoic is represented by a single formation consisting mainly of sandstone and siltstone. Outcrops are limited to a small area on the south coast where the formation lies nonconformably on Precambrian crystalline rocks, and is overlain unconformably by Cambrian strata; (2) the Paleozoic sediments consist mainly of shelf-type carbonate strata. They are divisible into fifteen formations with a total exposed thickness of about 3700 m. Most formations maintain relatively uniform characteristics throughout the report area. However, the three youngest formations, which outcrop in extreme western parts of the island, exhibit noteworthy facies relationships, with two shelf-type carbonate formations in southern parts of the island giving place laterally to graptolitic rocks in the north. Unconformities occur within the Paleozoic succession: between Lower and Middle Cambrian rocks; and probably between rocks of Late Ordovician and Early Silurian ages; (3) three easily weathered formations are preserved in a series of grabens developed in the Paleozoic terrane of western Devon Island. They are: 1. the Hassel Formation, nonmarine sandstone, Albian to Cenomanian; 2. the Kanguk Formation, marine shale, Turonian to Campanian; 3. the Eureka Sound Formation, mainly nonmarine sandstone, Maastrichtian; (4) the older of two formations within the limits of the Haughton crater consists of impact breccia. The younger consists of lake sediments.

Devon Island is cut by numerous, steeply-dipping, normal faults.

3479 THURSTON, H. (1986)

Icebound Eden; Equinox, May-June 1986, pp. 72-78; 81-85.

Fifty million years ago, Canada's high Arctic islands were a warm lowland swamp. Where they also an evolutionary hotbed?

3480 TRETTIN, H.P. (1987)

Pearya: a composite terrane with Caledonian affinities in northern Ellesmere Island; Can. J. Earth Sci., Vol. 24, No. 2, pp. 224-245.

In Ellesmere Island, the Canadian Shield and Arctic Platform are flanked on the northwest by the lower Paleozoic Franklinian mobile belt, which comprises an unstable shelf (miogeocline) and a deep-water basin, divisible into an inner sedimentary belt and an outer sedimentary - volcanic belt. Both are tied to the shelf by interlocking facies changes, but additional exotic units may be present in the outer belt.

Pearya, bordering the deep-water basin on the northwest, is divisible into four successions. Succession I comprises sedimentary and(?) volcanic rocks, deformed, metamorphosed to amphibolite grade, and intruded by granitic plutons at 1.0-1.1 Ga. Succession II consists mainly of platformal sediments (carbonates, quartzite, mudrock), with smaller proportions of mafic and siliceous volcanics, diamictite, and chert ranging in age from Late Proterozoic (Hadrynian) to latest Cambrian or Early Ordovician. Its concealed contact with succession I is tentatively interpreted as an angular unconformity. Succession III (Lower to Middle Ordovician?) includes arc-type and ocean-floor volcanics, chert, mudrock, and carbonates and is associated with fault slices of Lower Ordovician (Arenig) ultramafic - mafic complexes - possibly dismembered ophiolites. The faulted contact of succession III and the ultramafics with succession II is unconformably overlapped by succession IV, 7-8 km of volcanic and sedimentary rocks ranging in age from late Middle Ordovician (Blackriverian = early Caradoc) to Late

Silurian (late Ludlow?). The angular unconformity at the base of succession IV represents the early Middle Ordovician (Llandeilo-Llanvirn) M'Clintock Orogeny, which was accompanied by metamorphism up to amphibolite grade and granitic plutonism. Pearya is related to the Appalachian-Caledonian mobile belt by the Grenville age of its basement, the age of its ultramafic-mafic complexes, and evidence for a Middle Ordovician orogeny, comparable in age and character to the Taconic. By contrast, the Franklinian mobile belt has a Lower Proterozoic (Aphebian) - Archean basement and was not deformed in the Ordovician. Stratigraphic-structural evidence suggests that Pearya was transported by sinistral strike slip as three or more slices and accreted to the Franklinian deep-water basin in the Late Silurian under intense deformation. The inferred sinistral motion is compatible with derivation from the northern Caledonides.

3481 TRETTIN, H.P. (1987)

Investigations of Paleozoic geology, northern Axel Heiberg and northwestern Ellesmere islands; in Current Research, Part A, Geol. Surv. Can., Paper 87-1A, pp. 357-367.

The Rens Fiord Complex of Axel Heiberg Island is divided into: (1) interstratified basalt and carbonate of Early Cambrian or Hadrynian age; (2) dolostone and minor limestone of probable Early Cambrian age (facies equivalent of Ella Bay Formation?); (3) the Grant Land Formation (Lower Cambrian); and (4) the Hazen Formation (Lower Cambrian to Lower Silurian). The Svartevaeg Formation probably is a thrust-faulted facies equivalent of the Silurian Lands Lokk Formation. The basal Carboniferous succession includes a thin volcanic unit.

Steeply inclined to subhorizontal thrusts in northern Axel Heiberg Island, directed both to the northeast and the southwest, are attributed to deformations of Late Silurian-Early Devonian, and post-Early Devonian to pre-Visean ages.

On northwestern Ellesmere Island, the sandy and argillaceous member C of the Lands Lokk Formation represents a submarine fan facies that ranges in age from latest Llandovery or Wenlock to Ludlow. The chert-rich sediments are comparable to formations of northeastern Greenland and may have been affected by sinistral strike slip.

3482 TRETTIN, H.P. (1987)

Pre-carboniferous geology, M'Clintock Inlet map-area, northern Ellesmere Island, Interim Report and Map, Geol. Surv. Can., Open File No. 1652.

A program to complete the reconnaissance of northern Ellesmere Island was carried out from 1975 to 1984. In the M'Clintock Inlet area Trettin investigated the pre-Carboniferous succession and some younger intrusions during parts of the 1977, 1979, 1980, 1981, 1982 and 1984 seasons, and Mayr parts of the upper Paleozoic succession during parts of the 1977, 1979 and 1982 seasons. Modern turbine engine helicopters were used from 1977 onward.

The Quaternary geology of parts of the M'Clintock Inlet map-area is being studied by D. Lemmon under the supervision of Dr. J. England of the Department of Geography, University of Alberta.

3483 TRETTIN, H.P. (1988)

Early Namurian (or older) alkali basalt in the Borup Fiord Formation, northern Axel Heiberg Island, Arctic Canada; in Current Research, Part D, Geol. Surv. Can., Paper 88-1D, pp. 21-26.

Unmetamorphosed but spilitized amygdaloidal flows, identified as alkali basalt on the basis of stable trace element ratios, occur 16.7 to 48.5 m above the base of the Borup Fiord Formation in an area south of Rens Fiord, northern Axel Heiberg Island. Limestone 35 to 36.5 m above the volcanics has yielded conodonts of early Namurian (Arnsbergian) age. The volcanics constitute a local member within the Borup Fiord Formation that either is correlative with part of the Audhild Formation in northwestern Ellesmere Island or slightly older. Outcrops of these two units occur in a northeasterly trending belt that is parallel to the axis of the Sverdrup Basin. The volcanism was caused by rifting and occurred in nonmarine or shallow marine settings.

3484 TRETTIN, H.P., and PARRISH, R. (1987)

Late Cretaceous bimodal magmatism, northern Ellesmere Island: isotopic age and origin; Can. J. Earth Sci., Vol. 24, No. 2, pp. 257-265.

In the Yelverton Bay region of northwestern Ellesmere Island, bimodal intrusive and volcanic rocks are associated with a major fault in the Proterozoic-Cambrian rocks of the Pearya Terrane. The Wootton intrusion consists mainly of gabbro with lesser amounts of granitic and hybrid rocks; the Hansen Point volcanics are composed of felsic rocks and basalt. Plutonic zircons are very slightly discordant, but volcanic zircons have unusually high degrees of inheritance. Interpreted U/Pb zircon ages of 92.0 ± 1.0 Ma for the Wootton intrusion (assuming a wide range of inheritance ages) and of 88^{+20}_{-21} Ma for the Hansen Point volcanics are close to the 93 Ma average of hornblende K/Ar dates obtained earlier for a small quartz diorite pluton in central northernmost Ellesmere Island. All fall into the early Late Cretaceous and indicate correlation with mafic volcanics of the Cenomanian-Turonian Strand Fiord Formation of eastern Axel Heiberg Island. The upper intercept age for the Hansen Point volcanics (1150^{+41}_{+39} Ma) suggests

that the felsic component in the bimodal suites was in part derived from the upper Middle Proterozoic (Neohelikian) basement gneiss. Limited field observations on the Wootton intrusion also are compatible with the hypothesis that the granitic component represents sialic basement, melted by mafic intrusion at depth during an extensional tectonic regime.

3485 TRETTIN, H.P., and FRISCH, T. (1987)

Bedrock, geology, Yelverton Inlet map-area, northern Ellesmere Island, Interim Report and Map, Geol. Surv. Can., Open File No. 1651.

This report is a provisional account of the bedrock geology of the Yelverton Inlet map-area, as known in 1987. Because of the numerous and important remaining problems, it is likely that the picture presented here will be changed substantially by further studies, planned for 1988. Emphasis is on local features; tectonic interpretations that require a broader overview are only briefly discussed in the following section. The Quaternary geology of parts of the area is presently being studied by J.A. Evans of the Department of Geography, University of Alberta.

3486 TRETTIN, H.P., PARRISH, R., and LOVERIDGE, W.D. (1987)

U-Pb age determinations on Proterozoic to Devonian rocks from northern Ellesmere Island, Arctic Canada; Can. J. Earth Sci., Vol. 24, No. 2, pp. 246-256.

This paper presents age determinations on six units of the Franklinian deep-water basin and the Pearya Terrane of northern Ellesmere Island and discusses their tectonic implications.

Four different fractions of detrital zircon from the Lower Cambrian Grant Land Formation of the deep-water basin all have average $^{207}Pb/^{206}Pb$ ages of 2.2-2.4 Ga, suggesting that the sediments were derived mainly from Aphebian-Archean parts of the Canadian Shield rather than from the Neohelikian crystalline basement of Pearya, as assumed earlier. The first evidence for Ordovician arc-type volcanism in the northern part of the deep-water basin is provided by a Llandeilo(?) zircon age of $454.7^{+9.7}_{-4.5}$ Ma, but the fault-bounded volcanic unit could be exotic.

Four major stratigraphic successions are recognized in Pearya. Present zircon studies confirm that succession I has been affected by a 1.0-1.1 Ga orogeny, as inferred earlier by Sinha and Frisch from a Rb-Sr isochron. A zircon age of $503.2^{+7.8}_{-1.7}$ Ma on a rhyolite demonstrates that that succession II extended into the Late Cambrian or Early Ordovician.

Granitic intrusions in the Pearya Terrane, at Cape Richards and Cape Woods, are, respectively, Middle Ordovician (463 ± 5 Ma) and Devonian (382 ± 18 Ma or, more likely, 390 ± 10 Ma) in age on the basis of combined zircon and sphene determinations. They are post-tectonic with regard to major deformations in the Middle Ordovician and Late Silurian. Both have a significant component of xenocrystic zircon, which appears to have been derived from succession I of Pearya on the basis of upper intercept ages.

3487 VAN BERKEL, J.T. (1986)

A structural study of evaporite diapirs, folds and faults, Axel Heiberg Island, Canadian Arctic Islands; Gua Papers of Geology, Series 1, No. 26-1986, Amsterdam, 149 p.

The Sverdrup Basin, Canadian Arctic Islands, is filled with late Paleozoic, Mesozoic and early Tertiary sediments. A thick unit of evaporites is located at the base of the sedimentary sequence and plays an important role during the deformation of the sedimentary strata.

3488 VANDERMEER, I.J.M., and BOULTON, G. (1985)

Contrasts in form and sediment distribution between some glaciomarine fjords - Spitsbergen and Baffin Island; Abstract in 14th Arctic Workshop, Arctic Land-sea interaction, Nov. 6-8, 1985, p. 72.

Comparisons are made between the overall form of fjords in Spitsbergen and Baffin Island. Baffin Island fjords have steeper margins and lack a large platform just above sea level compared with Spitsbergen examples.

This strongly influences the overall distribution of sedimentary facies in the fjords and the gross geometry of sediment bodies.

2995 VAN WAGONER, N.A., DABORN, G., and MUDIE, P. (1986)

Recent Arctic "Reefs"; Abstract in GAC, MAC, CGU-AGC, AMC, UCG Joint Annual Meeting, Program of Abstracts, Vol. 11, Carleton Univ., Ottawa, Ontario, May 19-21, 1986, p. 140.

3187 VAN WAGONER, N.A., WILLIAMSON, M-C., ROBINSON, P.T., and GIBSON, I.L. (1986)

First samples of acoustic basement recovered from the Alpha Ridge, Arctic Ocean: new constraints for the origin of the ridge; J. Geodynamics, Vol. 6, No. 1-4, pp. 177-196. CESAR Contr. No. 34.

3489 VINCENT, J-S. (1985)

Land evidence for Late Cenozoic sea level fluctuations in areas adjoining the Beaufort Sea in the western Canadian Arctic; Abstract in 14th Arctic Workshop, Arctic Land-sea interaction, Nov. 6-8, 1985, pp. 44-47.

Sediments and landforms, adjacent to the Beaufort Sea, record fluctuations of Late Cenozoic sea levels associated with both glacio-isostatic depression related to northwesterly flowing continental ice advances and interglacial eustatic transgressions. Table 1 presents the sea level data and Figure 1 portrays glacial limits in the area. The evidence is particularly good on Banks Island whereas on the mainland Arctic Coastal Plain it has in many places been destroyed by widespread ice-thrusting, intensive thermokarst activity, and extensive coastal erosion.

3490 VINCENT, J-S. (1986)

Framework of Quaternary events in the northern interior plains of Canada; in Correlation of Quaternary deposits and events around the margin of the Beaufort Sea: Contributions from a joint Canadian-American workshop, April 1984; Geol. Surv. Can., Open File Report 1237, pp. 7-9.

Continental glaciers from west and northwest of Hudson Bay reached the Beaufort Sea on several occasions during the Quaternary. Glacial limits proposed by numerous authors are plotted and tentatively correlated on Figure 4-1. On the basis of limited radiometric data, ages are assigned on the limits. Sediments exposed in coastal cliffs and river bluffs provide an exceptional record, particularly on the Banks Island and Beaufort Sea coasts, of Quaternary preglacial, glacial, interglacial, and marine history. Events recorded in various areas of the western Canadian Arctic Archipelago and on the northern Interior Plains region of the Mainland are presented and correlated in Table 4-1. Pertinent radiometric age determinations are included. Suites of Quaternary sediments can be interpreted using a model in which interglacial periods, characterized by the deposition of organic bearing terrestrial and perimarine deposits, precede or follow glacial periods, characterized by transgressive marine (warping of the crust due to ice build-up), glacial per se, and regressive marine (glacio-isostatic recovery during ice retreat) events.

3491 VINCENT, J-S. (1988)

Late Tertiary and Early and Middle Pleistocene glacial and nonglacial record of Banks Island, Western Canadian Arctic Archipelago; Abstract in, GAC, MAC, CSPG Joint Annual Meeting, May 23-25, 1988, St. John's, Newfoundland, Program with Abstracts, Vol. 13, p. A130.

Surficial geology mapping as well as stratigraphic, radiometric and paleomagnetic investigations in the southwestern Arctic archipelago have led to the identification of pre-Late Pleistocene (>130 ka) glacial deposits and nonglacial beds which are often richly fossiliferous. These have made it possible to infer and compare some of the climatic/biotic changes during the period spanning the Late Tertiary to the Sangamonian. At Worth Point and Duck Hawk Bluffs, plant macrofossils and arthropods in Worth Point Formation nonglacial beds overlying Tertiary Beaufort Formation sands and gravels indicate that southern Banks Island was characterized by a larch-dominated forest-tundra in the Late Pliocene. In the Early Pleistocene (>730 ka) most of Banks Island and extensive areas of the southwestern Queen Elizabeth Islands were covered by northwestward advancing continental ice during the Banks Glaciation, which was the most extensive Quaternary glaciation recorded in the western Arctic. Following that glacial event, a long nonglacial interval, the Morgan Bluffs Interglaciation, is recorded in at least five sites on Banks Island. Although larch may have grown on southern Banks Island, most fossiliferous sites indicate a low Arctic tundra environment. Recent paleomagnetic investigations have confirmed that the Brunhes/Matuyama geomagnetic boundary (730 ka) occurs in the upper part of the Morgan Bluffs Formation. In the later part of the Middle Pleistocene, ice of the Thomsen Glaciation advanced as far west as eastern Banks Island. Because deposits of pre-Sangamonian age are not common, the Banks Island record is important for reconstruction of past Arctic climates and it provides proxy data to help assess the impact of future natural or human induced environmental changes.

3492 WASHBURN, A.L. (1988)

Soil Displacement in Sorted Circles, Resolute Area, Cornwallis Island, Canadian High Arctic; in Proc. Fifth International Conf. on Permafrost, August 2-5, 1988, Trondheim, Norway, Poster Presentation A3.20.

Lines of dowels originally inserted to depths of 100 and 200 mm across sorted circles were repeatedly surveyed over a 3-year period. Measurements of dowel heave, lean, and lateral displacement provided evidence on circle activity. Subject to certain assumptions, the evidence suggests that the cumulative soil displacement was radial and that its velocity near the surface increased linearly from zero at the center of a circle to a maximum at the stony border. This permits an estimate of the minimum age of circles. Radial displacement decreased with depth and was probably negligible below 100 mm. Although the radial displacement pattern supports the convection hypothesis for the development of sorted circles, it does not necessarily prove their origin.

3188 WEBER, J.R. (1986)

The Alpha Ridge: gravity, seismic and magnetic evidence for a homogenous, mafic crust; in Polar Geophysics, eds. G.L. Johnson and K. Kaminuma, J. Geodynamics, Vol. 6, pp. 117-136. CESAR Contr. No. 33.

2996 WEBER, J.R., and COOPER, R.V. (1988)

Crustal structure of the Alpha Ridge and Eastern Canada Basin; Abstract in Joint GAC, MAC, CSPG Annual Meeting May 23-25, 1988, Memorial Univ. of Newfoundland, St. John's, Nfld., Program of Abstracts, Vol. 13, p. A13.

3493 WILLIAMSON, M-C. (1988)

Magmatism in Mesozoic extensional provinces: examples from the Sverdrup Basin and eastern Canadian Continental Margin; Abstract in, GAC, MAC, CSPG Joint Annual Meeting, May 23-25, 1988, St. John's, Newfoundland, Program with Abstracts, Vol. 13, p. A135.

Despite a growing data base from offshore wells and marine surveys, the role of magmatism at rifted continental margins is poorly understood. Seismic studies of North Atlantic margins suggest a correlation among the extent of syn rift volcanic activity, thermal regime in the underlying mantle and behavior of continental lithosphere during rifting. Some of the models proposed can be tested by integrating geophysical, stratigraphic and petrological data using concepts of melt generation and extraction. However, many studies of offshore igneous rocks lack the necessary detail on volcanic stratigraphy and subsidence history of the host basins to permit this type of quantitative modelling.

Petrological and geophysical data from the Sverdrup Basin, Canadian Arctic, can be used to test thermo-mechanical models of basin evolution. The Cretaceous igneous province is well studied from exposures on Axel Heiberg and northern Ellesmere Islands. The petrochemistry of extrusive and intrusive rocks suggests that the character of magmatism was determined by partial melting events that occurred prior to initial rifting or during the long interval of thermal subsidence. The distribution of compositional types across the basin is correlated with the degree of lithospheric thinning, as inferred from gravity data and subsidence analysis.

Several aspects of the tectono-magmatic evolution of the Sverdrup Basin can be applied to the early development of rifted continental margins. These are discussed with special reference to Mesozoic igneous provinces of the eastern Canadian continental margin.

3494 WILLIAMSON, M-C, MUECKE, G.K., and CLARKE, D.B. (1987)

Petrology of rift-related continental basalts, Sverdrup Basin, Canadian Arctic; Abstract in GAC-MAC Joint Annual Meeting, Univ. Saskatchewan, May 25-27, 1987, Program with Abstracts, Vol. 12, p. 101.

Cretaceous igneous rocks of the Sverdrup Basin constitute a major continental basalt province in which intrusive magmatism predominates over effusive activity. These voluminous tholeiitic magmas were emplaced in an extensional setting over attenuated continental crust and are associated with bimodal suites near the basin margins. Volcanic rocks exposed on Axel Heiberg and northeastern Ellesmere Islands are assigned to one of three groups on the basis of stratigraphic position, eruptive style and lava geochemistry. Major and trace element analyses for 77 samples indicate that highly evolved, LREE-enriched tholeiites $(TiO)_2$ 2-3%; Mg# 38-46; La/Yb_n 3-5) are the dominant products of eruption. Lavas of Lower and Upper Cretaceous age display variations in frequency and volume of eruption, but rather uniform major element compositions. Important differences are noted in the geochemistry of the LIL elements K, Ba, Rb and Sr; and initial $^{87}Sr/^{86}Sr$ ratios, where youngest lavas are the most radiogenic. All three groups show a similar range of Nd values = +1 to -4. The geochemistry of extrusive rocks is examined in terms of AFC models in order to constrain possible mantle compositions. The generation and evolution of these magmas are directly related to renewed rifting and subsidence in the Sverdrup Basin which occurred contemporaneously with the opening of the Canada Basin. The episodic magmatism provides critical evidence on the geodynamics of this complex extensional setting.

3495 WINTERS, G.V., SYVITSKI, J.P.M., and MAILLET, L. (1985)

Distribution and dynamics of suspended particulate matter in Baffin Island fjords; Abstract in 14th Arctic Workshop, Arctic Land-sea interaction, Nov. 6-8, 1985, pp. 73-77.

In the fall of 1982, 1983 and 1985, a survey of the character of suspended particulate matter (SPM) in waters of 10 Baffin Island fjords was undertaken as part of project SAFE. In situ properties considered included CTD, monochromatic light attenuance and 3-D macrophotography profiling. More than 1000 CTD/rosette samples were analyzed for SPM concentration, grain size distribution, mineralogy (XRD), CHN and atomic C/N ratios, and optical and SEM analysis of filtrate residue (including energy-dispersive X-ray analysis). Samples were collected in the months of August and September. To further extend our study to other seasons, a climate-driven sediment-discharge stochastic model (SEDQ) was developed, based on reasonable estimates of drainage basin

characteristics (e.g. river type, lake filtering, topography, glacier distribution and movement), and on source and timing of discharge events. Air photos and LANDSAT images of water turbidity aided in the calibration of the model.

GEOPHYSICS

3179 ASUDEH, I., GREEN, A.G., and FORSYTH, D.A. (1988)

Canadian expedition to study the Alpha Ridge complex: results of the seismic refraction survey; Geophys. J., Vol. 92, pp. 283-301.

3496 ASUDEH, I., FORSYTH, D.A., JACKSON, H.R., STEPHENSON, R., and EMBRY, A. (1988)

The Ice Island refraction surveys; Abstract in, Proc. GAC, MAC, CSPG Joint Annual Meeting, May 23-25, 1988, St. John's, Newfoundland, Program with Abstracts, Vol. 13, p. A4.

The 1985 and 1986 Ice Island based refraction surveys covered a transition zone along the Canadian Polar Margin north of Axel Heiberg Island. 840 km of reversed profile data with average recording density of 5 km was collected. Along the inner shelf, the upper 700 m with a velocity of 3.7 km/s are interpreted as Tertiary-Cretaceous strata overlying 5 km of deformed Lower Paleozoic strata with a velocity of 5 km/s capped by Upper Paleozoic-Triassic clastics and carbonates and/or Cretaceous volcanics. The lower unit with a velocity of 5.8 km/s most likely consists of Proterozoic-Lower Paleozoic rocks. Beneath the outer shelf, up to 4 km of strata with a velocity of 2.2 km/s probably represent Tertiary-Cretaceous clastics overlying material with a velocity of 4.5 km/s interpreted as a sedimentary succession of either Cretaceous-Tertiary clastics or Upper Paleozoic to Cretaceous strata. Beneath this section, a probable Proterozoic-Lower Paleozoic lower crustal layer with a velocity of 6.2 km/s extends to a Moho depth of about 25 km. Beneath the transitional onshore-offshore line, a Neogene sedimentary basin is floored by faulted blocks of probably deformed Proterozoic to Lower Paleozoic rocks on the landward side and possibly Cretaceous to Lower Tertiary rocks on the seaward side.

3236 BISCHOFF, L., and OSKIERSKI, W. (1985)

First results of a multidisciplinary analysis of the Haughton Impact Crater, Devon Island, Canada. II Structural Geology; Abstract in, Proc. XVI Lunar and Planetary Science Sym., Houston, Texas, pp. 65-66.

3238 BISSON, J.G., BURNS, R.A., DALLIMORE, S.R., GAGNÉ, R.M., GOOD, R.L., HUNTER, J.A., JUDGE, A.S., LAFLECHE, P., PULLAN, S.E., BURN, C.R., HARRISON, W.D., MORACK, J.L., NEAVE, K.G., and MacAULAY, H.A. (1988)

Geotechnical investigations off northern Richards Island, N.W.T. - 1987; Geol. Surv. Can., Open File 1707, 147 p.

3497 BLATTER, H. (1987)

Stagnant ice at the bed of White Glacier. Axel Heiberg Island, N.W.T., Canada; Annals of Glaciology, Vol. 9, pp. 1-4.

A total of 400 soundings along 15 profiles were obtained on White Glacier, Axel Heiberg Island, N.W.T. with a monopulse radar equipment that was rebuilt according to a model of the US Geological Survey. The resulting data allowed maps to be compiled of the ice thickness for the glacier tongue. The radio echo-sounding data and englacial temperature measurements give some indication of the existence of stagnant ice in depressions of the glacier bed in the accumulation zone of White Glacier.

3208 BUTLER, R.S. (1985)

The Northwest Passage Propagation Experiment: Report of the 1983-1984 Measurement Program; Communications Canada, CRC Report No. 1391, 42 p.

3498 CARSEY, F.D. (1985)

Summer Arctic Sea Ice Character From Satellite Microwave Data; J. Geophys. Res., Vol. 90, No. C3, pp. 5015-5034.

In situ microwave data for the microscale properties of sea ice are combined with satellite data on the macroscale properties to construct an interpretation method for satellite data on sea ice for the warm season. Scatterometer, or calibrated radar, data give information on ice surface conditions, and radiometer data give information on areal concentrations of ponds and leads. The pond data are determined by examining fractional areas of exposed ice and using parameterized lead areas. These results are used to develop diffuse-illumination surface albedo estimates for the time of maximum ponding, near day 195, and that of minimum ice cover, near day 258. The estimated ponding albedos range from 0.5 to 0.6, and ice cover minimum albedos range from 0.6 to 0.8. During summer, the 37-GHz radiometer data are nearly independent of sea ice properties and are dominated by atmospheric and snow cover conditions. Lower-frequency data are increasingly useful for interpreting ice conditions. Substantial anisotropy in backscatter is recorded in scatterometer data at 14 GHz, with surface resolu-

tion of 50 km showing 90° anisotropy in the 0.5-1 dB range. In Nimbus 5 and Seasat data, some variation in satellite-recorded microwave properties during the period between 195 and 258 cannot be directly interpreted but are thought to be due to weather.

3499 COX, T.P., MEREU, R.F., and OVERTON, A. (1988)

Seismic reflection results from an ice island over the Arctic Continental Shelf; Abstract in, Proc. GAC, MAC, CSPG Joint Annual Meeting, May 23-25, 1988, St. John's, Newfoundland, Program with Abstracts, Vol. 13, p. A27.

In 1982 an Arctic ice island, 3 km by 5 km and 41 m thick, broke away from the Ward-Hunt ice shelf on Ellesmere Island and began drifting southwest with the ocean currents. This island provided a stable platform in the polar ice cap, for the seismic reflection exploration of the Arctic Continental Shelf north of Axel Heiberg Island. A seismic reflection array, consisting of a 107 station, 3.53 km, main arm and a 12 station, 2.4 km, cross arm, was constructed on the island. A set of 6 sec CMP data was recorded from the 13 shot points for each kilometre the island drifted. Each charge, 1 kg of 60% Geogel, was detonated 110 m beneath the ice surface. Over July and August, 1985, a total of 87 sets of shots were recorded. The raw record sections were dominated by very strong water waves and water layer reverberations. Up to 14 distinct water bottom multiples are seen in both the raw shot gathers and the CMP stacked sections. Various filters and processing techniques were used to reduce the water noise. First break refraction analysis revealed 700-800 m of locally varying shallow sedimentary rock over lying a high velocity (possibly Precambrian) basement. The CMP sections contain numerous short discontinuous reflections suggesting a lack of structure in the basement rock. Common shot gather stacking increased the signal to noise ratio and revealed an extensive roughly horizontal reflection in the Precambrian basement at a depth of approximately 4.2 km.

3251 DALLIMORE, S.R., and DAVIS, J.L. (1987)

Ground probing radar investigations of massive ground ice and near surface geology in continuous permafrost; in Current Research, Part A, Geol. Surv. Can., Paper 87-1A, pp. 913-918.

3500 EARTH PHYSICS BRANCH (1985)

Gravity anomaly map; Gulf of Boothia - Prince Regent Inlet, Area: Latitude N68°00' - N74°00', Longitude W86°00' - W98°00' Bouguer on land, free air offshore, Observations: 3725, Map Scale: 1:1,000,000.

3180 FORSYTH, D.A., MOREL-A-L'HUISSIER, P., ASUDEH, I., and GREEN, A.G. (1986)

Alpha Ridge and Iceland-products of the same plume? J. Geodynamics, Vol. 6, pp. 197-214, CESAR Contr., No. 30.

3181 FORSYTH, D.A., ASUDEH, I., GREEN, A.G., and JACKSON, H.R. (1986)

Crustal structure of the northern Alpha Ridge beneath the Arctic Ocean; Nature, Vol. 322, No. 6077, pp. 349-352.

3501 FORSYTH, D.A., ASUDEH, I., BROOME, J., HALPENNY, J., and EMBRY, A.F. (1988)

Regional geophysics of the Canadian Polar Margin; Abstract in, Proc. GAC, MAC, CSPG Joint Annual Meeting, May 23-25, 1988, St. John's, Newfoundland, Program with Abstracts, Vol. 13, p. A40.

The Canadian "passive" polar margin is characterized by many features that appear similar to those observed along the North American Atlantic margin. A zone of negative magnetic anomalies, the Polar Shelf Magnetic Anomaly (PSMA) characterizes the Canadian polar margin from north of Ellesmere Island to the Beaufort Sea.

The Beaufort Sea is bisected by a central linear magnetic low. The crust of the western Beaufort Sea, between the central magnetic low and Alaska, has different structural (magnetic) and dynamic (seismicity) properties than the crust to the east. Positive ocean-floor magnetic trends in the western Beaufort are conformable with the regional arcuate tectonic trends of northeastern Alaska-western Yukon terrane and the adjacent offshore arches.

From (a) changes in margin strike, (b) changes in the character and relationship between potential field anomalies and (c) the pattern of extensional features across the northern Sverdrup Basin, it is suggested that margin rifting varied along strike. Principal controlling factors were pre-existing basement features and the development of the Alpha Ridge.

The seismic activity along the PSMA near the large elliptical gravity highs, indicates adjustment along margin structures, possibly to the loading effects of sedimentary depocenters. The rift geometry of the Canadian polar margin as delineated by the gravity and magnetic anomalies, must be considered in tectonic reconstructions.

3210 FRENCH, H.M. (1983)

Terrain and environmental problems associated with exploratory drilling, northern Canada, in Proc. 4th Inter. Permafrost Conf., Final Proceedings, Nat. Academy Press, Washington, D.C. pp. 129-132.

3318 GRIEVE, R.A.F. (1988)

The Haughton Impact Structure: Summary and Synthesis of the Results of the HISS Project; Meteoritics, Vol. 23, No. 3, pp. 249-254.

3502 HAJNAL, Z., and OVERTON, A. (1988)

Reflection survey on Hobson's Choice Ice Island, Arctic Ocean; Abstract in, Proc. GAC, MAC, CSPG Joint Annual Meeting, May 23-25, 1988, St. John's, Newfoundland, Program with Abstracts, Vol. 13, p. A50.

A permanently installed 120 channel seismic reflection system on the Hobson's Choice Ice Island at the northern tip of Axel Heiberg Island in the Arctic ocean, recorded close to 2000 field records in the summers of 1985 and 1986 while the ice platform drifted irregularly in a north westernly direction. The acoustically highly contrasting surface ice, ocean water and solid continental margin floor generated extremely strong reverberating waves which resulted in complex contaminated field records. With the implementation of several specially developed noise suppression algorithms, the dramatically improved signal levels permitted the assembly of 13 spatially distributed multifold seismic section segments along the 160 km travel path of the island. Both refraction signal analysis and large scale vertical stacking based velocity spectral computations indicate that the ocean floor of the continental margin is formed by competent sedimentary rock sequences. According to preliminary estimates the reflection signals successfully imaged the underlying strata to a depth somewhat over 5000 m. Five reflecting horizons were recognized. Two of these, which indicate gentle westernly dip, were easily traceable through the entire survey area. The others were localized revealing a rather complete subsurface environment along the northern segment of the Canadian Arctic Continental Margin.

3319 HAJNAL, Z., SCOTT, D., POHL, J., and ROBERTSON, P.B. (1985)

First results of multidisciplinary analysis of the Haughton impact crater, Devon Island, Canada. V. Seismic studies; Abstract in, Proc. XVI Lunar and Planetary Science Sym., Houston, Texas, pp. 312-313.

3213 HEGINBOTTOM, J.A., and SINCLAIR, M.P. (1985)

Cumulative Index to Permafrost Conference Proceedings (1958-1983); Geol.Surv. Can., Open File Report 1135, 215 p.

3328 HEGINBOTTOM, J.A., and VINCENT, J-S. (1986)

Correlation of Quaternary deposits and events around the margin of the Beaufort Sea: Contributions from a joint Canadian-American workshop, April 1984; Geol. Surv. Can., Open File Report 1237, 60 p.

3331 HILL, P.R. (1987)

Beaufort Sea coastal zone geotechnics; Geol. Surv. Can., Report of Field Activities: 1987, Open File 1902, 81 p.

3332 HILL, P.R., and BLASCO, S.M. (1986)

Implications of a Beaufort Shelf relative sea-level curve to Arctic Mid and Late Wisconsinan Glacial events; in Correlation of Quaternary deposits and events around the margin of the Beaufort Sea: Contributions from a joint Canadian-American workshop, April 1984; Geol. Surv. Can., Open File Report 1237, pp. 55-56.

3338 HORIGUCHI, K. (1985)

Electric Conductivity of an Ice Core Obtained from Massive Ground Ice in Characteristics of the Massive Ground Ice Body in the Western Canadian Arctic Related to Paleoclimatology, 1984-1985, ed. K. Fujino, Ins. Low Temp. Sci., Hokkaido Univ., Japan, pp. 37-45.

2990 JACKSON, M.R., MUDIE, P.J., and BLASCO, S.M. (1985)

Initial geological report on CESAR - the Canadian Expedition to study the Alpha Ridge, Arctic Ocean; Geol. Surv. Can., Paper No. 84-22, 177 p.

2991 JACKSON, M.R. (1985)

Knowledge of the Alpha Ridge Prior to CESAR; in Geol. Surv. Can., Paper 84-22, pp. 11-14, CESAR Contr. No. 8.

3182 JACKSON, M.R., and JOHNSON, G.L. (1986)

Summary of Arctic geophysics; J. Geodynamics, Vol. 6, pp. 245-262.

3345 JACKSON, H.R. (1988)

A seismic stratigraphy for the Polar Margin; Abstract in, Proc. GAC, MAC, CSPG Joint Annual meeting, May 23-25, 1988, St. John's, Newfoundland, Program with Abstracts, Vol. 13, p. A60.

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The Nares Strait gravity anomaly and its implications for crustal structure; Can. J. Earth Sci., Vol. 22, pp. 1322-1328.

3347 JACKSON, K.C., and HALLS, H.C. (1985)

The age of the North Mokka Anticline, Axel Heiberg Island, Canadian Arctic Archipelago: an application of the paleomagnetic fold-test; Bull. Can. Petroleum Geol., Vol. 33, No. 2, pp. 227-235.

3356 JUDGE, A. (1986)

Permafrost distribution and the quaternary history of the Mackenzie-Beaufort Region: a geothermal perspective; in Correlation of Quaternary deposits and events around the margin of the Beaufort Sea: Contributions from a joint Canadian-American workshop, April 1984; Geol. Surv. Can., Open File Report 1237, pp. 41-45.

3503 JUDGE, A.S., TAYLOR, A., BURGESS, M. and ALLEN, V. (1979)

Geothermal investigations at Illisarvik - 1979; Report No. 15, in Drained lake experiments for investigation of the growth of permafrost in the western Arctic, ed. J.A. Hunter, a progress report prepared for the Permafrost Subcommittee, Assoc. Comm. on Geotech. Res., Nat. Res. Council of Canada, 3 p.

3357 JUDGE, A., and JONES, I. (1988)

Mapping the distribution and properties of natural gas hydrates in Canada; in Proc. Fifth International Conf. on Permafrost, August 2-5, 1988, Trondheim, Norway, Poster Presentation B4.17.

3504 JUDGE, A., TAYLOR, A., DUGUID, A., ALLEN, V., HILL, M., WOODROFFE, D., HARRINGTON, J., BAUDAIS, D., AND UHRICH, I. (1987)

Automatic data acquisition system installed in offshore Canadian Arctic well: monitoring precise temperatures by acoustic telemetry; in Proc. OCEANS'87 Conf., Marine Technology Society and IEEE Ocean Engineering Society, Halifax, N.S., Vol. 1, pp. 156-160.

A methodology has been developed to instrument an offshore petroleum exploration well for long term downhole temperature observations. A demonstration deployment was completed successfully in May, 1985 at a well in 244 m of water in the Canadian Arctic. The data acquisition system acquired well temperatures to 800 m below the sea floor at 4 hour intervals for most of the first year following system deployment and well abandonment. Data was transmitted acoustically through the water to a recording package left on the sea ice. The concept has application in monitoring temperatures and other parameters in abandoned holes and in production wells. The recording package could be mounted in a buoy for open sea areas.

3367 KOVACS, L.C., SRIVASTAVA, S.P., and JACKSON, H.R. (1986)

Results from an aeromagnetic investigation of the Nares Strait Region; in Polar Geophysics, eds. G.L. Johnson and K. Kaminuma, J. Geodynamics, Vol. 6, No. 1-4, pp. 91-110.

3370 KURFURST, P.J. (1986)

Geotechnical investigation of seabottom sediments, Tuktoyaktuk area, District of Mackenzie; in Current Research, Part A, Geol. Surv. Can., Paper 86-1A, pp. 775-778.

3505 KURFURST, P.J. (1987)

Cone penetration tests of the nearshore zone sediments off Richards Island, Northwest Territories; in Current Research, Part A, Geol. Surv. of Canada, Paper 87-1A, pp. 939-944.

A "Hogentogler" electronic cone penetrometer system has been used to characterize unfrozen seabottom sediments and to determine their temperature regime in the nearshore zone in the southern Beaufort Sea. Typical sounding records, temperature profiles and their preliminary interpretation are presented.

3218 LEHN, W.H. (1985)

A simple parabolic model for the optics of the atmospheric surface layer; Applied Mathematical Modelling, Vol. 9, pp. 447-453.

3219 LEHN, W.H. (1986)

Anomalous Sunrises in Polar Regions; Polar Record, Vol. 23, No. 144, pp. 205-207

3220 LEHN, W.H. (1986)

A Three-Parameter Inferior Mirage Model for Optical Sensing of Surface Layer Temperature Profiles; IEEE Transactions on Geoscience and Remote Sensing, Vol. GE-24, No. 6, pp. 940-946.

3221 LEHN, W.H. (1986)

Terrestrial Images transmitted by the Novaya Zemlya Effect; OSA Topical Meeting on Meteorological Optics, Honolulu, Apr. 3-4, Technical Digest, pp. 33-35.

3222 LEHN, W.H., and MORRISH, J.S. (1985)

An inferior mirage model for the optical sensing of surface layer temperature profiles; International Geoscience and Remote Sensing Sym., Amherst, Mass., Oct. 7-9, Digest, Vol. 1, p. 363.

3223 LEHN, W.H., and WALLACE, R.E. (1986)

Continuous-Tone Mirage Images computed from Digitised Source Photographs, OSA Topical Meeting on Meteorological Optics, Honolulu, Apr. 3-4, Technical Digest, pp. 36-37.

3506 LOUDEN, K.E. (1988)

Marine heat flow observations on the Arctic Continental Shelf; Abstract in, Proc. GAC, MAC, CSPG Joint Annual Meeting, May 23-25, 1988, St. John's, Newfoundland, Program with Abstracts, Vol. 13, p. A75.

Approximately 30 new heat flow measurements have been taken during 1986-87 on the Arctic Continental Shelf near Axel Heiberg Island as part of the Ice Island Project. Additional data using remote ice camps to extend coverage into the Canada Basin are planned for Spring 1988. All observations of thermal gradient and in-situ conductivity were made using a modified marine probe which includes digital recording of 9 thermistors spaced over 4-7 m.

Initial analysis of data from the Axel Heiberg headland in water depths of 150±250 m shows some regions of linear temperature gradients which are spatially separated by zones of changing bottom water temperatures and correspondingly non-linear gradients. Heat flow values from the thermally stable regions vary from 20 to 50 mW/m^2. Such values are similar to previous observations of shallow probes on the shelf further west near Prince Patrick Island as well as of marine boreholes within the Sverdrup Basin. This suggests that the Eurekan orogeny has probably not affected either region. Much higher gradients which are measured in land wells within the Sverdrup Basin are probably all caused by transient cooling of upper layers which have been recently uplifted by post-glacial rebound, as previously suggested by Lachenbruch's (1957) analysis of initial measurements at Resolute Bay.

3392 MACKAY, J.R., and LESLIE, R.V. (1987)

A simple probe for the measurement of frost heave within frozen ground in a permafrost environment; in Current Research, Part A, Geol. Surv. Can., Paper 87-1A, pp. 37-41.

2993 MacLEAN, B. (1986)

CSS HUDSON Cruise 86-027; Geol. Surv. Can., Atlantic Geoscience Centre Cruise Report, 36 p.

3394 MacLEAN B., VILKS, G., and SONNICHSEN, G. (1988)

Quaternary geology of Arctic interisland channels; Abstract in Proc. GAC, MAC, CSPG Joint Annual Meeting, May 23-25, 1988, St. John's, Newfoundland, Program with Abstracts, Vol. 13, p. A77.

3507 NEWITT, L.R., and NIBLETT, E.R. (1986)

Relocation of the north magnetic dip pole; Can. J. Earth Sci., Vol. 23, pp. 1062-1067.

An analysis of data gathered between May 13 and May 18, 1984, gives a new position for the north magnetic dip pole of 77.0°N, 102.3°W. The pole has moved an average of 11.6 km per year approximately northwest during the past decade. Data used in the analysis consisted of absolute observations of the magnetic declination, inclination, and total intensity for seven sites in the vicinity of the pole. Variometer data from King Christian Island were used in conjunction with the absolute observations to calculate mean values for the quietest 6 h interval during the survey period. Additional data from Resolute Bay observatory allowed further reduction of the observations to representative annual mean values, centred at 1983.9, from which the pole position was determined using the novel method of spherical cap harmonic analysis.

3184 NIBLETT, E.R., KURTZ, R.D. and NICHAUD, C. (1987)

Magnetotelluric measurements over the Alpha Ridge; Phys. Earth Planet Inter., Vol. 45, pp. 101-118.

3419 OSTERTAG, R., ROBERTSON, P.B., STÖFFLER, D., AND WÖHRMEYER, C. (1985)

First results of a multidisiplinary analysis of the Haughton Impact crater, Devon Island, Canada, III Petrography and Shock Metamorphism; Abstract in, Proc. XVI Lunar and Planetary Science Sym., Houston, Texas, pp. 633-634.

3425 PARAMESWARAN, V.R., JOHNSTON, G.H., and MACKAY, J.R. (1985)

Electrical potentials developed during thawing of frozen ground; in Proc. Fourth Inter. Sym. on Ground Freezing, Sapporo, Japan, August 5-7, 1985, Nat. Res. Council, Vol. 1, pp. 9-16.

3430 POHL, J., ECKSTALLER, A., ROBERTSON, P.B., and HAJNAL, Z. (1985)

First results of a multidisciplinary analysis of the Haughton Dome, impact structure,. Devon Island, Canada, IV. Geophysics; Abstract in, Proc. XVI Lunar and Planetary Science Sym., Houston, Texas, pp. 669-670.

3431 POHL, J., ECKSTALLER, A., and ROBERTSON, P.B. (1988)

Gravity and Magnetic Investigations in the Haughton Impact Structure, Devon Island, Canada; Meteoritics, Vol. 23, pp. 235-238.

3448 ROBERTSON, P.B. (1988)

The Haughton Impact Structure, Devon Island, Canada: Setting and History of Investigations; Meteoritics, Vol. 23, pp. 181-184.

3449 ROBERTSON, P.B., OSTERTAG, R., BISCHOFF, L., OSKIERSKI, W., HICKEY, L.J., and DAWSON, M.R. (1985)

First results of a multidisciplinary analysis of the Haughton Impact Crater, Devon Island, Canada. I Geology, Abstract in, Proc. XVI Lunar and Planetary Science Sym., Houston, Texas, pp. 702-703.

3455 SCHRÖDER, C.J., MEDIOLI, F.S., and COLE, F.E. (1988)

Benthic foraminifera of Arctic environments: ice island versus Lancaster Sound; Abstract in, GAC, MAC, CSPG Joint Annual Meeting, May 23-25, 1988, St. John's, Newfoundland, Program with Abstracts, Vol. 13, pp. A109-A110.

3457 SCOTT, D., and HAJNAL, Z. (1988)

Seismic Signature of the Haughton Structure; Meteoritics, Vol. 23, pp. 239-247.

2994 SOBCZAK, L.W., and WEBER, J.R. (1987)

Gravity and bathymetry taken along seismic refraction lines from the Canadian Ice Island during 1985 and 1986; in Current Research, Part A, Geol. Surv. Can., Paper 87-1A, pp. 299-304. Ice Island Contr. No. 10.

3463 SOBCZAK, L.W., MAYR, U., and SWEENEY, J.F. (1986)

Crustal section across the polar continent - ocean transition in Canada; Can. J. Earth Sci., Vol. 23, No. 5, pp. 608-621.

3508 SOBCZAK, L.W., and HALPENNY, J.F. (1988)

Gravity anomaly maps of the Arctic (Free-Air, Bouguer, Total Isostatic, Residual Isostatic and Sobczak); Abstract in, Proc. GAC, MAC, CSPG Joint Annual Meeting, May 23-25, 1988, St. John's, Newfoundland, Program with Abstracts, Vol. 13, p. A114-115.

Five types of gravity anomaly maps are presented for the Arctic region and are evaluated for their utility for geological studies. The maps are produced from an original database containing 355,120 randomly distributed gravity observations which was reformated as 90,095 gridded gravity values. These values were plotted against elevation, or rock equivalent topography for water, for free-air, Bouguer, and residual isostatic anomalies to test the correspondence between the respective gravity anomalies and elevations. All of these anomalies exhibit various significant degrees of correlation with elevation which hinders their geological interpretation. A new type of gravity map, provisionally named Sobczak anomaly map, was derived by applying relationships between gravity anomaly and elevation for various types of crust to the residual isostatic anomalies. This map enhances variations in gravity related to geological structure, and eliminates those variations related to continent-ocean boundaries, water-rock interfaces a topography/bathymetry and associated isostatic roots/antiroots.

The merits of this new type of gravity anomaly map are illustrated. Generally, the zero anomaly contour outlines areas of volcanism and intrusion, oceanic and continental crust, and tectonically active regions during the last 100 Ma. Within an oceanic region, negative anomalies may indicate older (>100 Ma) oceanic crust or pieces of continental crust. Within a continental region positive anomalies correspond with recently (<100 Ma) active areas as indicated by mountains, volcanism,

intrusions and sedimentary deposits, whereas negative anomalies indicate unactivated, older (>100 Ma) areas.

3464 SONNICHSEN, G.V., and ATKINSON, A. (1987)

A small boat survey of the Lougheed - King Christian - Cameron Islands Region of the northwestern Canadian Arctic using open water leads; Geol. Surv. Can., Open File No. 1903, Report of Field Activities, AGC Program No. 87-100, 23 p.

3465 SONNICHSEN, G.V., and VILKS, G. (1987)

A small boat seismic reflection survey of the Lougheed Island Basin - Cameron Island Rise - Desbarats Strait region of the Arctic Island channels using open water leads; in Current Research, Part A, Geol. Surv. Can., Paper 87-1A, pp. 877-882.

3509 STEFFEN, K. (1986)

Ice Conditions of an Arctic Polynya: North Water in Winter; J. of Glaciology, Vol. 32, No. 112. pp. 383-390.

The surface condition of the North Water was investigated during two winters (i.e. the three polynyas: Smith Sound polynya, Lady Ann Strait polynya, and Barrow Strait polynya). Since no detailed information was available on ice conditions and the extent of open water during winter, radiometric temperature measurements of the sea surface had to be taken along a flight line of 2650 km from an altitude of 300 m. From November to March 1978-79 and 1980-81, 14 remote-sensing flights were carried out. On the basis of the radiometric measurements, the following ice types were identified: ice-free, dark nilas, light nilas, grey ice, grey-white ice, and white ice. A comparison between the thermal and the visual ice classification (the latter being based on grey tones of the aerial images) showed a deviation of 3%. The analysis showed that in November, December, and January more than 50% of the Smith Sound polynya was covered by young ice, nilas, and ice-free, whereas in February and March white ice was dominant. Moreover, it was found that the two polynyas in Smith Sound and Lady Ann Strait were much smaller than previously believed. In Barrow Strait, a semi-permanent polynya was observed in the winter of 1980-81. The occurrence of polynyas in Barrow Strait seems to be connected with the location of the fast-ice edge. On the basis of the calculated ice-type distribution and heat-flux rates for different ice types, an energy loss of 178 W m^{-2} was found on the surface of the Smith Sound polynya due to open water and thin ice for the winter months November to March. Compared with other ice-covered sea surfaces in the Arctic, the heat release by sea-water in the Smith Sound polynya is about 100 W m^{-2} larger.

3466 STEPHENSON, R.A., RICKETTS, B.D., BOYD, J.B., and LOSIER, I. (1988)

Geological interpretation of new gravity data from northern Axel Heiberg and northwestern Ellesmere Islands, Canadian Arctic Archipelago; Abstract in, GAC, MAC, CSPG Joint Annual Meeting, May 23-25, 1988, St. John's, Newfoundland, Program with Abstracts, Vol. 13, p. A117.

3467 STEPHENSON, R.A., ZELT, B.C., and LANE, L.S., ASUDEH, I., FORSYTH, D.A., SPENCER, C., and ELLIS, R.M. (1988)

Crustal structure from regional seismic refraction data in the Mackenzie Delta - Beaufort Sea - Northern Yukon area; Abstract in, Proc. GAC, MAC, CSPG, Joint Annual Meeting, May 23-25, 1988, St. John's, Newfoundland, Program with Abstracts, Vol. 13, pp. A117-A118.

3185 SWEENEY, J.F., and WEBER, J.R. (1986)

Progress in understanding the age and origin of the Alpha Ridge, Arctic Ocean; J. Geodynamics, Vol. 6, pp. 237-244, CESAR Contr. No. 29.

3471 SYVITSKI, J.P.M. (1985)

Subaqueous slope failures within seismically active Arctic fjords; Abstract in 14th Arctic Workshop, Arctic Land-sea interaction, Nov. 6-8, 1985, pp. 60-63.

3473 TAUXE, L., and CLARK, D.R. (1987)

New paleomagnetic results from the Eureka Sound Group: Implications for the age of early Tertiary Arctic biota; Geol. Soc. America Bull., Vol. 99, pp. 739-747.

3510 TAYLOR, A. (1988)

Objective paleoenvironmental reconstruction from deep temperature logs, Canadian Arctic Islands; Abstract in, Proc. GAC, MAC, CSPG Joint Annual Meeting, May 23-25, 1988, St. John's, Newfoundland, Program with Abstracts, Vol. 13, p. A123.

Deep ground temperatures preserve a record of past temperature conditions at the earth's surface. A simple method has been used to extract, in a statistical sense, a general trend of the surface temperature history for the last millenium at 15 petroleum exploration wells in the Arctic Islands. The method fully accounts for the dependence of the subsurface temperature field on rock thermal conductivity, although the general imprecision in

measurement of this latter parameter is the greatest limitation to the method.

Generally, reconstructed mean surface temperatures during the Little Ice Age and the Little Climatic Optimum are about 4K lower, and 1-3K higher, respectively, than today's surface temperatures throughout the region. This variation may be interpreted as arising from a similar change in mean air temperatures, a change in ground condition such as snow cover or vegetation, or some portion of both. In this polar desert, most sites today are covered by less than 20 cm snow by the late winter and little vegetation in the short summer. However, reconstructed temperatures at one well, for instance, suggest surface temperatures today are higher by 1-4K than at any time in the past 1000 years; over one metre of loose granular snow has been observed during several visits to this site in late winter over the past ten years.

3511 TAYLOR, A. (1988)

A constraint to the Wisconsinan glacial history, Canadian Arctic Archipelago; J. Quaternary Sci., Vol. 3, No. 1, pp. 15-18.

Thick ice-bearing permafrost is not observed today beneath the deeper channels of the central Queen Elizabeth Islands, Canadian Arctic Archipelago. Analysis of a precision temperature log recently obtained at an offshore well near Ellef Ringnes Island indicates that the thermal regime beneath the seabed is in equilibrium with today's marine environment. If thick permafrost similar to that observed on land today had existed in the Pleistocene in areas that are presently offshore, then such permafrost must have started melting no later than 25,000 years ago in order to allow the present thermal regime to evolve. This suggests that the inter-island channels must have been water-filled at least by that date.

3186 TAYLOR, A., JUDGE, A. and ALLEN, V. (1986)

Terrestrial Heat Flow from project CESAR, Alpha Ridge, Arctic Ocean; J. Geodynamics, Vol. 6, pp. 137-176, CESAR Contr. No. 32.

3512 TAYLOR, A., and ALLEN, V. (1986)

Geothermal Program on the CCGS NAHIDIK, cruises 1981-83, Canadian Beaufort Sea; Energy, Mines & Res. Canada, Earth Phys. Br., Gravity, Geothermics and Geodynamics Div., Internal Report. No. 86-05, 138 p.

The Canadian Coast Guard has made the vessel "Nahidik" available since 1975 for a couple of weeks late each season to a group of EMR scientists for geotechnical work. The Geothermal Group has had one or more personnel on the ship each year; this report describes the work carried out on the 1981, 1982 and 1983 cruises and presents the basic data and some preliminary interpretation.

The 1981-83 cruises covered a large area of the Beaufort Shelf, extending from the central area north of Tuktoyaktuk to just east of Herschel Island in the west, adding to the regional coverage began in 1980. Generally, only that part of the Shelf and Canyon under 30 m or more water was surveyed. In these three cruises, 33 gradiometer casts with penetrations generally greater than 2 m were made, 363 conductivity measurements were made on core, and, as part of the field trial and proving of the time domain reflectometry method in saline sediments, 15 estimates of the unfrozen water content and 27 of the DC electrical conductivity were made using prototype equipment.

3513 TAYLOR, A.E., and ALLEN, V. (1987)

Shallow sediment temperature perturbations and sediment thermal conductivities, Canadian Beaufort Shelf; Can. J. Earth Sci., Vol. 24, pp. 2223-2234.

A regional survey of sediment temperatures and thermal conductivities was conducted at 33 stations across the outer shelf of the Canadian Beaufort Sea. Techniques developed for deep-ocean heat-flow investigations were used to study the upper 3 m of sediments. Temperature-depth profiles exhibit curvatures that may be explained by seasonal changes in bottom-water temperature; some curvatures may arise from other causes. It is unlikely that thermal effects of the underlying, degradational permafrost can be detected from such shallow temperatures because of the magnitude of, and lack of independent knowledge of, these transient and local influences. Thermal conductivities measured on sediment cores and corrected to -1°C range from 0.9 to 2.4 $W m^{-1} K^{-1}$ (average 1.26 ± 0.2 $W m^{-1} K^{-1}$). These values are higher than typical conductivities to deep-ocean sediments. The wide range of thermal conductivities observed across the outer Beaufort Shelf may be explained by the presence of a varying fraction of quartz sand that represents a component of high conductivity.

3514 TAYLOR, A., and JUDGE, A. (1978)

Mining companies assist in studies of permafrost in Northern Quebec; The Northern Miner, Nov. 30, 1978, pp. D1 and D14.

This brief article has attempted to show how simple physical observations of permafrost can provide considerable insight into its natural dynamics and its response to man-induced disturbances. The natural thermal regime, the resulting permafrost distribution and the response of permafrost to natural and man-induced changes are important to the earth scientists and to the mining engineer alike. Cooperative programmes of investigation thus are continuing the traditions established by early workers.

3515 TAYLOR, A., and JUDGE, A. (1988)

Reconstruction of marine transgression history from an offshore ground temperature profile, Esso Angasak L-03 wellsite, Beaufort Sea, in Current Research, Part D, Geol. Surv. Can., Paper 88-1D, pp. 137-142.

Marine transgression in arctic regions represents a major thermal event, as sea water near its freezing point encroaches on a permafrost landscape. The history of recent transgression is preserved in precise temperatures measured to 48 m below the seabed in a geotechnical borehole at the Esso Angasak L-03 wellsite, offshore Cape Dalhousie, Beaufort Sea. Simple geothermal modelling suggests that the thermal event accompanying marine transgression at this site occurred at least 300 years ago. This implies an average (maximum) rate of coastal retreat of 6 to 7 m/year over the past three centuries. Due to limitations in the models, the actual time of transgression was probably somewhat earlier, with lower rates of retreat. The models suggest that mean surface temperatures prior to marine transgression were 2 to 3 K lower than today, possibly reflecting the nature of the Little Ice Age in the region.

3516 TAYLOR, A., and JUDGE, A. (1988)

The terrestrial heat flow, Canadian Arctic Islands: thermal conditions on the eastern boundary of the Canada Basin; Abstract in, Proc. GAC, MAC, CSPG Joint Annual Meeting, May 23-25, 1988, St. John's, Newfoundland, Program with Abstracts, Vol. 13, pp. 123-124.

Precise temperature measurements to 500-1100 m depth have been obtained from 40 petroleum exploration wells in the Canadian Arctic Archipelago. Permafrost dynamics, the effects of recent shoreline emergence and uncertainties in thermal conductivity complicate thermal analyses in many cases but the terrestrial heat flow has been obtained with confidence at 15 wells. After standard corrections for effects of topography and recent climate, we obtain terrestrial heat flows of 50-70 mWm^{-2} at the onshore wells, and under 40 mWm^{-2} at an instrumented offshore well. Possible corrections for Pleistocene surface temperatures may have significant implications to the Wisconsinan glacial history of the Archipelago.

The higher value of heat flow is similar to the world average heat flow for continental areas that experienced Mesozoic to Tertiary orogeny, while the lower limit is more typical of shields. Values bracket heat flows published for the Canada Basin to the northwest (50-57 mWm^{-2}). It appears that little heat remains from orogenic events that largely terminated in the Tertiary. Of particular interest are the constraints implied by these data to the growth of permafrost at coastal areas that have been undergone recent emergence from the sea.

3517 TAYLOR, A., and JUDGE, A. (1988)

Analysis of precise temperatures from an offshore Canadian Arctic well: constraints to the onshore paleoenvironment and permafrost dynamics; in Proc. Fifth International Conf. on Permafrost, August 2-5, 1988, Trondheim, Norway, Poster Presentation B1.10.

In May, 1985 a 800 m multithermistor cable and automatic data acquisition system were installed in a petroleum exploration well lying in 244 m of water, offshore Ellef Ringnes Island, Canadian Arctic Archipelago. A preliminary analysis of the precise temperatures at this well suggests that the geothermal regime is in equilibrium with the present marine environment, with little perturbation due to transient disturbances or groundwater movement. Hence, the well is ideally suited to characterize the regional geothermal regime, and to constrain similar studies undertaken at onshore wells where substantial effects of paleoclimates, shoreline regression and permafrost dynamics complicate the situation.

This constraint has been useful in the analysis of deep temperature logs from onshore wells within the region. The analysis suggests that permafrost observed today at some coastal sites has aggraded entirely since these sites became emergent from the sea several thousand years ago due to Holocene marine regression. An objective paleoenvironmental reconstruction has been undertaken at some inland wells unaffected by marine regression. Ground surface temperatures during the Little Ice Age appear to have been several degrees lower than today; this may be interpreted as arising from a similar change in air temperature, a change in ground condition such as snow cover, or some portion of both.

3518 TAYLOR, A., JUDGE, A., and ALLEN, V. (1987)

Abandonment of Arctic wells preserved for subsurface temperature observations: a status report; Energy, Mines & Res. Canada, Geol. Surv. Can., Permafrost Research Section, Internal Report, 22 p.

The former Geothermal Service of the Earth Physics Branch, EMR undertook subsurface temperature measurements throughout northern Canada since the mid-1960s. The data, with maps and tables of permafrost thicknesses derived from it, have been published regularly as volumes in the Geothermal Series; the most recent edition is Taylor, Burgess, Judge and Allen (1982).

3519 TAYLOR, A., JUDGE, A., ALLEN, V., HILL, M., WOODROFFE, D., HARRINGTON, J., BAUDAIS, D., DUGUID, A., and UHRICH, I. (1986)

Downhole Temperature Acquisition System Installed in an Offshore Canadian Arctic

Well; EOS, Vol. 67, No. 13, The Oceanography Report, pp. 154-155.

Recently, a prototype system has been installed in an offshore petroleum exploration well in the Canadian Arctic to demonstrate the technology of measuring precise wellbore temperatures to hundreds of meters depth at frequent intervals over a period of several years. We believe that this is the first time that an automatic data acquisition system has been installed in an offshore well.

This system has been developed over the past several years by the Earth Physics Branch of the Canadian Department of Energy, Mines, and Resources (EMR, Ottawa).

2996 WEBER, J.R., and COOPER, R.V. (1988)

Crustal structure of the Alpha Ridge and Eastern Canada Basin; Abstract in, Joint GAC, MAC, CSPG Annual Meeting, May 23-25, 1988, Memorial Univ. of Newfoundland, St. John's, Nfld., Program of Abstracts, Vol. 13, p. A13.

2997 WEBER, J.R., and HALLIDAY, D.W. (1984)

Bathymetry and gravity of the Alpha Ridge; Abstract in Proc. Can. Geophys. Union, 11th Annual Meeting, Dalhousie Univ., Halifax, N.S., May 29 - June 1, 1984, pp. 83-84.

2999 WEBER, J.R. (1987)

Maps of the Arctic Basin Sea Floor Part II: Bathymetry and Gravity of the Alpha Ridge: The 1983 CESAR Expedition; Arctic, Vol. 40, No. 1, pp. 1-15. CESAR Contr. No. 20.

3188 WEBER, J.R. (1986)

The Alpha Ridge: gravity, seismic and magnetic evidence for a homogenous, mafic crust; in Polar Geophysics, eds. G.L. Johnson and K. Kaminuma, J. Geodynamics, Vol. 6, pp. 117-136. CESAR Contr. No. 33.

3000 WELMERS, A. (1986)

Final Field Report, P.C.S.P. survey, Gulf of Boothia, Committee Bay, and Pelly Bay, Proj. File No. 5452-7318; Fisheries and Oceans, Can. Hydrographic Serv., Central Region, internal report, 45 p.

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3192 ALT, B.T. (1987)

Developing Synoptic Analogs for Extreme Mass Balance Conditions on Queen Elizabeth Island Ice Caps; J. Climate and Applied Meteorology, Vol. 26. No. 12, pp. 1605-1623.

3193 ALT, B.T., KOERNER, R.M., FISHER, D.A., and BOURGEOIS, J.C. (1985)

Arctic climate during the Franklin Era, as deduced from ice cores; in The Franklin Era in Canadian Arctic history 1845-1859, ed. P.D. Sutherland, Nat. Museum of Man Mercury Series, Archaeological Survey of Canada Paper No. 131, pp. 69-92.

3497 BLATTER, H. (1987)

Stagnant ice at the bed of White Glacier. Axel Heiberg Island, N.W.T., Canada; Annals of Glaciology, Vol. 9, pp. 1-4.

3520 BLATTER, H. (1987)

On the thermal regime of an Arctic valley glacier: a study of White Glacier, Axel Heiberg Island, N.W.T., Canada; J. Glaciology, Vol. 33, No. 114, pp. 200-211.

From 1974 to 1981, a total of 32 boreholes was drilled on White Glacier and vertical ice-temperature profiles measured. The data obtained allowed the construction of three longitudinal and four transverse profiles of the two-dimensional temperature distributions. Thus, an extensive layer of temperate or near-temperate ice was discovered close to the bedrock in the lowest part of the glacier tongue. It was also found that the temperature distribution cannot be in a steady state, since there is a temperature minimum 100-150 m below the glacier surface in the accumulation area. A simple numerical model calculation shows that this minimum can be mostly explained by the general climatic warming since 1880. The 10 m temperatures show diffuse relations to climatic conditions and balance zones. A simple scheme for extrapolating "surface temperatures" is discussed.

3142 BOURGEOIS, J.C. (1986)

A pollen record from the Agassiz Ice Cap, northern Ellesmere Island, Canada; Boreas, Vol. 15, No. 4, pp. 345-354.

3143 BOURGEOIS, J.C., and KOERNER, R.M. (1985)

Pollen analysis as collected by the Transglobe Expedition; in Report on Scientific Work of the Transglobe Expedition 1979-1982; ed. R. Fiennes, pp. 296-302.

3521 BRADLEY, R.S., and SERREZE, M.C. (1987)

Mass balance of two High Arctic plateau ice caps; J. Glaciology, Vol. 33, No. 113, pp. 123-128.

Mass-balance measurements have been renewed on two small ice caps on north-eastern Ellesmere Island. Original stake networks were established in 1972 and 1976. Since then, both ice caps have experienced significant mass losses averaging -70 to -140 kg m^{-2} a^{-1}. They have also decreased in area. The equilibrium line in this area has averaged around 1150 m for the last decade or so. The ice caps are remnants of former climatic conditions and are out of equilibrium with contemporary climate.

3522 BRADLEY, R.S., and SERREZE, M.C. (1987)

Topoclimatic studies of a High Arctic plateau ice cap; J. Glaciology, Vol. 33, No. 114, pp. 149-158.

Meteorological observations on and around a small, exposed plateau ice cap on north-eastern Ellesmere Island, N.W.T., Canada, were carried out in the northern summers of 1982 and 1983. The objective was to assess the effect of the ice cap on local climate as the melt season progressed. In 1982, seasonal net radiation totals were lowest on the ice cap and greatest at the site farthest from the ice cap. The ice-cap site received only 35% of net radiation totals on the surrounding tundra. This reflects a gradient in albedo; albedo changed most markedly away from the ice cap as the summer progressed. A thermal gradient was observed along a transect perpendicular to the ice-cap edge; this gradient was greatest at low levels (15 cm) and was maximized under cloud-free conditions. The "cooling effect" of the ice cap was less at the start of the ablation season than later. Low-level inversions occurred more frequently over the ice cap than over the snow-free tundra. Overall, melting degree days on the ice cap were only 40-65% of those on the adjacent tundra. A model of interactions between the atmosphere and a snow and ice cover, or a snow-free tundra/felsenmeer surface is proposed. Observations indicate that the ice cap has a cooling effect on the lower atmosphere relative to the adjacent snow-free tundra; this effect is absent when snow cover is extensive (as in 1983).

3261 DYKE, A.S. (1987)

A reinterpretation of glacial and marine limits around the northwestern Laurentide Ice Sheet; Can. J. Earth Sci., Vol. 24, No. 4, pp. 591-601.

3263 DYKE, A.S., and PREST, V.K. (1987)

Late Wisconsinan and Holocene history of the Laurentide Ice Sheet; Géographie physique et Quaternaire, Vol. XL1, No. 2, pp. 237-263.

3274 ENGLAND, J. (1985)

On the origin of high arctic fiords; Abstract in 14th Arctic Workshop, Arctic Land-sea interaction, Nov. 6-8, 1985, Dartmouth, N.S., p. 51-53.

3275 ENGLAND, J. (1985)

The late Quaternary history of Hall Land, northwest Greenland; Can. J. Earth Sci., Vol. 22, No. 10, pp. 1394-1408.

3276 ENGLAND, J. (1986)

Glacial erosion of a High Arctic valley; J. Glaciology, Vol. 32, No. 110, pp. 60-64.

3277 ENGLAND, J. (1986)

A Paleoglaciation level for north-central Ellesmere Island, N.W.T. Canada; Arctic and Alpine Res., Vol. 18, No. 2, pp. 217-222.

3278 ENGLAND, J. (1987)

The late Quaternary history of Hall Land, northwest Greenland: Reply; Can. J. Earth Sci., Vol. 24, No. 2, pp. 374-380.

3279 ENGLAND, J. (1987)

Glaciation and the evolution of the Canadian high arctic landscape; Geology, Vol. 15, pp. 419-424.

3280 ENGLAND, J., and BEDNARSKI, J. (1986)

Postglacial isobases from northern Ellesmere Island and Greenland: new data; Géographie physique et Quaternaire, Vol. XL, No. 3, p. 299-305.

3281 ENGLAND, J., and STEWART, T.G. (1985)

Isotope geochemistry of stratified Lake "A", Ellesmere Island, N.W.T., Canada: Discussion; Can. J. Earth Sci., Vol. 22, No. 4, pp. 647-648.

3523 EVANS, D.J.A., and FISHER, T.G. (1987)

Evidence of a periodic ice-cliff avalanche on north-west Ellesmere Island, N.W.T., Canadian High Arctic; J. Glaciology, Vol. 33, No. 113, pp. 68-71.

Evidence of a recent (1985) ice-cliff avalanche from an outlet lobe of a small plateau ice cap on north-west Ellesmere Island is discussed. Former avalanche events are evidenced by debris lying outside the 1985 avalanche material. Periodic activity seems to be linked to the build-up of melt water in the crevasses of the outlet lobe during the melt season. The exact magnitude and frequency of events are unknown. Some implications to geomorphology and sedimentology of sub-polar glaciers are discussed.

3524 FISHER, D.A., and KOERNER, R.M. (1986)

On the special rheological properties of ancient microparticle-laden Northern Hemisphere ice as derived from bore-hole and core measurements; J. Glaciology, Vol. 32, No. 112, pp. 501-510.

In the Northern Hemisphere, ice layers which have high microparticle concentrations (in particular late Wisconsin) are "softer" than modern or Holocene ice. Such ice deforms more readily in bore-hole tilt and closure measurements. This enhancement in flow, which is shown not to be related to c-axis concentration, has a maximum of three for late Wisconsin ice. The closure and tilt of a bore hole in the Agassiz Ice Cap, Ellesmere Island, drilled in 1977, has been followed every year since its drilling and the flow enhancement observed has been compared to the following quantities measured in the cores; microparticle concentration, $\delta(^{18}O)$, crystal size, c-axis, Ca, Na, conductivity, and density. Flow enhancement of the ice age and bottom ice was found to be unrelated to c-axis concentration and density. Enhancement of flow is best related to microparticle (or Ca) concentration which in turn seems to be inversely related to crystal size. The latter relationship also seems to hold for the Devon Island Ice Cap and Greenland. In future, modellers of northern ice ages should use model ice that is three times softer than modern or Holocene ice.

3525 HAYTHORNTHWAITE, T.W. (1986)

Topographic change of the Meighen Ice Cap; unpub. Ph.D. thesis, Dept. Geography, Carleton Univ., Ottawa, 102 p.

The results of a levelling survey conducted in 1985 across the Meighen Ice Cap, Arctic Canada, were compared to 1960 data to determine the extent of topographic change. While most of the surface of this stagnant ice cap has been substantially lowered, the summit area has gained height. Maps used to illustrate the results of mass balance observations for the period 1959 to 1985 confirm these conclusions and show that the spatial pattern of change has been quite constant over time. Ablation is the dominant factor in mass balance spatial distribution. Because the ice cap has probably always been stagnant, current trends are likely to be countered by other mechanisms before thickening and steepening introduce ice motion.

3336 HODGSON, D.A. (1985)

Extent of terrestrial and marine ice sheets in the western Queen Elizabeth Islands; Abstract in 14th Arctic Workshop, Arctic Land-sea interaction, Nov. 6-8, 1985, Dartmouth, N.S., pp. 228-229.

3337 HODGSON, D.A. (1985)

The last glaciation of west-central Ellesmere Island, Arctic Archipelago, Canada; Can. J. Earth Sci., Vol. 22, No. 3, pp. 347-368.

3526 JEFFRIES, M.O. (1986)

Glaciers and the morphology and structure of Milne Ice shelf, Ellesmere Island, N.W.T., Canada; Arctic & Alpine Res., Vol. 18, No. 4, pp. 397-405.

Milne Ice Shelf has an area of about 290 km^2 and an undulating topography of ridges and troughs (rolls) that is characteristic of arctic ice shelves. The geometry (wavelength, depth, and orientation) of the rolls varies considerably across the ice shelf and this is the basis for the division of the ice shelf into an outer unit, central unit, and inner unit. The units also correspond to thickness variations. The central unit is up to 100 m thick and there is an extensive series of moraines in which material is commonly found in conical mounds on the ice surface. The evidence from roll geometry, surface features, and ice thickness strongly suggests that much of central and outer Milne Ice Shelf consists of relic glacier tongues. The thinnest ice and greatest roll disorientation occurs in the inner unit. The latter might be explained by the periodic surging of Milne Glacier that restricts the linear development of the rolls. Although a landfast sea-ice cover perhaps existed in Milne Fiord ca. 4200 to 4100 BP, it was soon displaced by the glacier tongues that survive to this day. Glacier tongues have been found in ice island ARLIS II, and they have also been observed in Alfred Ernest Ice Shelf. This indicates that arctic ice shelves commonly grow as a result of the flow of glacier tongues in addition to in situ growth due to snow and ice accumulation on landfast sea ice.

3527 JEFFRIES, M.O. (1986)

Ice Island Calvings and Ice Shelf Changes, Milne Ice Shelf and Ayles Ice Shelf, Ellesmere Island, N.T.W.; Arctic, Vol. 39, No. 1, pp. 15-19.

Analysis of vertical air photographs taken in 1959 and 1974 reveals that a total of 48 km^2, involving 3.3 km^3, of ice calved from Milne and Ayles ice shelves between July 1959 and July 1974. In addition, Ayles Ice Shelf moved about 5 km out of Ayles Fiord. It still occupied this exposed position in July 1984. The ice losses and movements have allowed the growth of thick sea ice that has developed an undulating topography similar to but smaller scale than that of the ice shelves. It is suggested that regular monitoring of the coastal ice of northern Ellesmere Island would enable such changes to be registered and assessed, as they could be of concern to offshore operations in the Beaufort Sea.

3528 JEFFRIES, M.O., and KROUSE, H.R. (1984)

Isotope geochemistry of stratified water bodies on northern Ellesmere Island, Canadian Arctic, in Berichte des Zentralinstituts für isotopen-und strahlenforschung, Akademie der Wissenschaften der DDR, Leipzig, Vol. 84, pp. 159-169.

Lake A, Lake B, Disraeli Fiord, and Milne Fiord on the northern coast of Ellesmere Island are stratified with respect to salinity, temperature and isotopic composition. These parameters attest to freshwater overlying seawater. In the two lakes, the salinity gradients trap solar energy producing temperature maxima at about 20 m depth. In the fiords, water temperatures are lower due to heat transfer by ocean currents. The depth profiles of salinity and $\delta^{18}O$ show that ionic and molecular diffusion processes occur on a time scale of thousands of years in lakes "A" and "B", and suggest that Lake "B" has been isolated longer than Lake "A". Carbon and sulphur isotope data attribute excess HCO_3^- and SO_4^{2-} depletion in the underlying seawater of the lakes to extensive bacterial sulphate reduction. This modification is greater in Lake "B" than Lake "A" and is believed to be due to its longer time of isolation and higher water temperatures than Lake "A". The slow vertical mixing by diffusion in the lakes contrasts with the dynamic nature of the stratified fiords where ocean currents and eddies dominate.

3197 JEFFRIES, M.O., and KROUSE, H.R. (1984)

Arctic ice shelf growth, fiord oceanography and climate; Band, Vol. 20, Universitätsverlag Wagner, Innsbruck, pp. 147-153.

3358 KATO, K., FUJINO, K., HORIGUCHI, K., and SATO, S. (1985)

Oxygen Isotope Profile in a Massive Ice Body in Mackenzie Delta, N.W.T., Canada: Preliminary Report; in Characteristics of the Massive Ground Ice Body in the Western Canadian Arctic Related to Paleoclimatology, 1984-85; ed. K. Fujino, Inst. Low Temp. Sci., Hokkaido Univ., Japan, pp. 46-56.

3365 KLASSEN, R.A. (1985)

An outline of glacial history of Bylot Island, District of Franklin, N.W.T., in Quaternary Environments, Eastern Canadian Arctic, Baffin Bay and Western Greenland; ed. J.T. Andrews, Allen and Unwin, Boston, pp. 428-460.

3529 KOERNER, R.M. (1985)

Review of Ice Drilling Technology, Proceedings of the 2nd International Workshop/Symposium on Ice Drilling Technology, Calgary, Alberta, Canada, August 30-31, 1982, eds. G. Holdsworth, K.C. Kuivinen and J.H. Rand. Ab. Special Report 84-34, December 1984; Arctic, Vol. 38, No. 4, p. 349-350.

3530 KOERNER, R.M. (1966)

Preliminary report on analysis of a core from the Meighen Island Ice Cap; Polar Cont. Shelf. Proj., internal report, 6 p.

This progress report describes a fabric analysis of a 122 m core drilled from the Meighen Island Ice Cap and representing the total thickness of the cap just below its highest point (268 m asl). The Meighen Island Ice Cap is approximately oval in outline, has an area of 76 km^2, and covers about 1/10 the island. Paterson cored through the cap with a U.S. CRREL thermal corer in July 1965 and core recovery was complete. The author conducted research on the core on site in May and June 1966. The work consisted of (i) crystal c-axis orientation work using a Rigsby stage, (ii) crystal size measurements from photographs taken through polarised light, (iii) collection of dirt samples from dirt bands.

3531 KOERNER, R.M., FISHER, D.A., ALT, B.T., PARMANDI, M., and BOURGEOIS, J.C. (1986)

Polar Continental Shelf Project; Ice; No. 80, 1st issue, Glacier Studies - Arctic, p. 2.

Laboratory Investigations - Further work was done using the Reeh ice sheet model to compute a 3-dimensional Laurentide Ice Sheet using known marginal positions. Analysis of all data on the unique properties of Pleistocene ice and its

rheological implications was completed. In cooperation with AES (L. Barrie), variations of acid levels in High Arctic snows were analysed. Pollen analysis of one of the Agassiz Ice Cap cores has been completed. Mass balance results from four ice caps were studied. A new method for obtaining and using such measurements for climatic monitoring purposes was developed. In cooperation with S. Edlund (GSC), the relationship between summer climate and vegetation patterns in the High Arctic was studied. Work on the summer climate in the Queen Elizabeth Islands during the Franklin Period (as deduced from ice cores), and the part it played in the demise of the Franklin Expedition, was submitted for publication.

Field investigations - The mass balances of Meighen, Melville, Devon (northwest side) and Agassiz (northern side) ice caps were measured. Boreholes drilled on Agassiz Ice Cap were monitored for closure rates and bulk samples from one hole were melted from seven separate depths of over 100 m. A suite of snow/firn samples was collected for chemistry studies from the same site. Levelling traverses were made over Meighen Ice Cap and across Sverdrup Glacier (Devon Island) to check for advance or retreat of these glaciers.

3532 LAURIOL, B., CARRIER, Y., BEAUDET, H., and BINDA, G. (1986)

The Residual Snow Cover in the Canadian Arctic in July: A Means to Evaluate the Regional Maximum Snow depth in Winter; Arctic, Vol. 39, No. 4, pp. 309-315.

This paper examines the residual snow cover in the Canadian Arctic during the month of July in the period 1948-83 inclusive using air photographs. The study area includes the Ungava Peninsula, part of the District of Keewatin and the Arctic Archipelago, except for the mountainous regions to the west of the Labrador Sea, and Baffin Bay, where numerous snow fields and glaciers are present. In spite of the spatial discontinuity of the air photographs taken during the second half of July, the authors were able to study 555 519 km^2, or 46%, of the forementioned territory. Within this territory, 1899 km^2 are covered by residual snow during summer, or an average of 3336 $m^2 \cdot km^2$. A correlation of r=0.93 was observed between the residual snow cover in the different regions during the second half of July and the maximum snow cover thickness during winter measured by Environment Canada. A model permitting the estimation of the maximum snow cover thickness in regions where meterological stations do not exist was formulated. The model is applicable at small and medium scales. In addition, the authors propose that the Hudson Strait region is the most susceptible to the formation of glaciers if one hypothesizes that the regions with the thickest residual snow cover are the most susceptible to glaciation.

3161 McANDREWS, J.H. (1984)

Pollen Analysis of the 1973 Ice Core from Devon Island Glacier, Canada; Quaternary Res., Vol. 22, pp. 68-76.

3533 REEH, N., and THOMSEN, H.H. (1987)

An ice-sampling programme in the Thule area, North Greenland; Rapp. Gronlands geol. Unders., No. 135, pp. 81-84.

A glaciological programme was carried out as part of the NORDQUA 86 expedition to the Thule area, North Greenland, from 7 to 24 August 1986.

The expedition included researchers from the five Nordic countries and Great Britain and was organised by the Geological Museum, Copenhagen. The expedition had a Quaternary geological programme, as well as a glaciological programme dealing with the climatic history and ice-sheet dynamics before and during the last Ice Age in the area.

The glaciological programme involved collection of ice samples to be analysed for $\delta^{18}O$.

3440 RETELLE, M.J. (1986)

Glacial geology and Quaternary marine stratigraphy of the Robeson Channel area, Northeastern Ellesmere Island, Northwest Territories; Can. J. Earth Sci., Vol. 23, pp. 1001-1012.

HISTORY

2957 BEATTIE, O. (1985)

Elevated bone lead levels in a crewman from the last Arctic expedition of Sir John Franklin (1845-1848); in The Franklin Era in Canadian Arctic History 1845-1859, ed. Patricia D. Sutherland, National Museum of Man, Mercury Series, Archaeological Surv. Can. Paper No. 131, pp. 141-148.

3534 CHRISTIE, R.L. (1986)

Fort Conger: Crossroads of the High Arctic; MUSK-OX, Vol. 34, pp. 29-34.

The northernmost station of the International Polar Year of 1881-82 was Greely's Fort Conger, on northern Ellesmere Island. This site was first used in 1875 by HMS Discovery of the Nares expedition. In 1881, Lieutenant Greely of the U.S. Signal Corps built and occupied the station, which was used by no fewer than seven other expeditions during the following sixty years.

A map of Fort Conger has been constructed by the author from a survey carried out in 1965. Three distinct periods of High Arctic expedition are evident: (a) early British geographical exploration by ship (tins, barrel hoops); (b) systematic scientific project based on land (metal, clay, and glass artifacts from the late 1800s); and (c) wide-ranging geographical exploration, including poleward travel, by dog-sled (Thule-style sledging artifacts).

3535 JANES, R.R. (1986)

Review of The Franklin Era in Canadian Arctic History 1845-1859, ed. P.D. Sutherland, National Museum of Man Mercury Series, Archaeological Survey of Canada Paper No. 31, Ottawa; Arctic, Vol. 39, No. 4, pp. 374-375.

These papers are the result of a 1984 symposium organized by the editor of this volume, the purpose of which was to better understand the events that surrounded the disappearance of Franklin's third expedition and to examine the implications of that tragedy. In short, this volume is not only a remarkable testimony to the persistence of the desire to know Franklin's fate, but it is also an excellent demonstration of the need for multidisciplinary thinking in any problem solving. This latter point may, in fact, be a reflection of the editor's own perspective, as her archaeological research encompasses the earliest northern prehistory to the late 19th century in the High Arctic. This collection also makes another valuable contribution, and that is the directions for future research it offers to current and aspiring Franklin scholars. More importantly, the careful reader may also discern what not to do as the Franklin search continues, which it undoubtedly will. The mystery of it all remains simply overpowering - for the scholar, amateur and layperson alike. There is plenty of substance in this volume for all three appetites, thanks to the editor's sense of purpose and intellectual breadth.

3225 MacINNIS, J.B. (1985)

The Breadalbane Project: Implications for the discovery of Franklin's Ships; in The Franklin Era in Canadian Arctic history 1845-1859, e.d. P.D. Sutherland, Nat. Museum of Man Mercury Series, Archaeological Survey of Canada, Paper No. 131, pp. 174-184.

3226 MacINNIS, J. (1987)

Sailing the Northwest Passage by wind and muscle alone; Can. Geographic, Vol. 107, No. 3, pp. 26-33.

HYDROGRAPHY

3536 HIPKIN, K.G. (1985)

Polar Continental Shelf Project (P.C.S.P.) Survey; Fish. & Oceans, Can. Hydrographic Serv., Burlington, Ont., Final Field Report, Proj. No. 5452-7316, 44 p.

Originally this survey was scheduled to occupy the Arctic Ocean Ice Island off the coast of Axel Heiberg Island. However, due to logistical problems, the survey reverted to the previously planned location in the Gulf of Boothia. Here we collected depths at a two km spacing and gravity data at a six km spacing. The survey was a continuation of the 1984 Prince Regent Inlet survey.

The immediate goal was to ensure that the sounding coverage was such that Decca 6F would not be required for 1986. Instead, a shorter range system such as Syledis should be suitable to complete the Gulf of Boothia and Committee Bay.

3537 LUSK, B.M. (1985)

West Coast Surveys, Pacific Region, Beaufort Sea; Fish. & Oceans, Can. Hydrographic Serv., Sidney, B.C., Final Field Report, 47 p.

In February of 1985, after consultation with the Regional Director, Hydrography and the Regional Field Superintendent, a plan of surveys to be carried out in an area north of Kugmallit Bay to the existing shipping corridor was agreed upon. The survey line spacing was to be conducted at a scale of 1:20,000 and would add information for the updating of charts in the area as well as contribute substantial information to proposed pipelines which will terminate on or near Richards Island. This survey would be carried out in area 1, with areas 2 and 3 being carried out in subsequent years and the inshore surveyed as required.

3538 MACDONALD, R.W., WONG, C.S., and ERICKSON, P.E. (1987)

The Distribution of Nutrients in the Southeastern Beaufort Sea: Implications for Water Circulation and Primary Production; J. Geophys. Res., Vol. 92, No. C3, pp. 2939-2952.

Hydrographic data collected above the shelf and slope and the southeastern Beaufort Sea show marked contrast in surface properties of nutrients, temperature, salinity and oxygen between August 1974, a year when ice remained close to shore, and August 1975, a year with much open water. The near-surface properties are dominated by river inputs, biological activity, and the ice regime. Below the winter mixed zone (40-50 m), properties are similar to those observed elsewhere in the Arctic Ocean. Bering sea water is detected at 50-60 m as a very weak signal

in temperature, nutrients and oxygen. Upwelling in both years was observed at the eastern side of Mackenzie Canyon; this upwelling likely results from the interaction of coastal circulation with topography. Estimates of new productivity based on nutrient budgets are low (20 g C m^{-2} yr^{-1}) compared to temperate coastal waters, but fall in the range expected for the Arctic. In 1974, the heavy ice year, turbid water and ice cover appear to have reduced new production by about 30%. Calculations show that this production over the shelf could potentially supply a significant portion of the nutrients found in the upper halocline over a wide region of the Arctic Ocean by regeneration at the shelf bottom and transport off the shelf in brine drainage.

3201 PULKKINEN, H.W. (1973)

Hydrographic surveying with air cushion vehicles, Trials Report, Evaluation of modified retractable fixed strut echo sounder, December 10-19, 1971; Polar Cont. Shelf Proj., internal report, 27 p.

3539 ST. JACQUES, D.A., SANDILANDS, R.G., and SOLVASON, R.R. (1984)

1983 Tidal Survey of Prince Regent Inlet, N.W.T., Fish. & Oceans, Can. Hydrographic Serv., Burlington, Ont., Data Report, 54 p.

The Canadian Hydrographic Service (CHS), Central Region is undertaking a reconnaissance sounding survey of Prince Regent Inlet and the Gulf of Boothia during a two year period from 1984 to 1985. As a result, the Tides, Currents and Water Levels Section initiated a field project in 1983 to collect tidal data for sounding reductions in subsequent surveys. The data were also intended to expand the CHS understanding of tidal propagation in the Arctic Archipelago.

At the same time, the Oceanography Division of the Bayfield Laboratory for Marine Science and Surveys expressed interest in a joint tide and current survey. The two agents agreed that CHS would deploy four current metres near the tide gauge sites and that Oceanography Division would process and analyse the current meter data.

This report presents the results of the tidal survey. It consists of brief descriptions of the field techniques used to collect the data and the analytical methods used during processing. The data are presented in an Appendix at the end of the report.

3540 SANDILANDS, R.G., and SOLVASON, R.R. (1987)

1986 Tidal Survey in Committee Bay, Pelly Bay and Gulf of Boothia, N.W.T.; Fish. & Oceans, Can. Hydrographic Serv., Burlington, Ont., Data Report, 53 p.

As part of an ongoing project to study tidal propagation in the Arctic Archipelago and to support a hydrographic survey in the area, the Tides, Currents and Water Levels Division, Central and Arctic Region, deployed seven tides gauges in the Gulf of Boothia area. The location and the tidal station number assigned to each deployment is shown in Figure 1. Pressure data were collected from March 24 to April 30, 1986.

This report consists of a brief description of the field techniques used to collect the data and the analytical methods used during processing. The data are presented in an Appendix at the end of the report.

3541 SANDILANDS, R.G., and SOLVASON, R.R. (1987)

1987 Tidal Survey in Committee Bay and Pelly Bay, N.W.T.; Fish. & Oceans, Can. Hydrographic Serv., Burlington, Ont., Data Report, 53 p.

As part of an ongoing project to study tidal propagation in the Arctic Archipelago and to support a hydrographic survey in Pelly Bay, the Tides, Currents and Water Levels Division deployed four tides gauges in Pelly Bay and three gauges in Committee Bay. The location and the tidal station number assigned to each deployment is shown in Figure 1. Pressure data were collected from March 23 to April 29, 1987.

This report consists of a brief description of the field techniques used to collect the data and the analytical methods used during processing. The data are presented in an Appendix at the end of the report.

3542 SANDILANDS, R.G., SOLVASON, R.R., and ST. JACQUES, D.A. (1985)

1981 Tidal Survey of Norwegian Bay, N.W.T.; Fish. & Oceans, Can. Hydrographic Serv., Burlington, Ont., Data Report, 56 p.

As part of an ongoing project to study tidal propagation in the Arctic Archipelago the Tides, Currents and Water Levels Section, Central Region, deployed five tides gauges in the vicinity of Norwegian Bay during 1981. These gauges were installed for 45 days from March 4 to April 20, 1981.

This report presents the results of these five deployments, and also includes the results of a 145 day record collected between January 18 and June 12, 1981 for Panarctic Oil Ltd., Calgary, Alberta. It consists of brief descriptions of the field techniques used to collect the data and the analytical methods used during processing. The data are presented in an Appendix at the end of the report.

3543 SANDILANDS, R.G., SOLVASON, R.R., and ST. JACQUES, D.A. (1985)

1984 Tidal Survey of the Gulf of Boothia, N.W.T.; Fish. & Oceans, Can. Hydrographic Serv., Burlington, Ont., Data Report, 43 p.

As part of an ongoing project to study tidal propagation in the Arctic Archipelago, the Tides, Currents and Water Levels Section, Central Region, deployed six tides gauges in the Gulf of Boothia during 1984. Five of these gauges were installed from March 7 to April 21, 1984. The remaining gauge was deployed for one year at the east end of Bellot Strait.

This report presents the results of the month-long deployments at five sites in the Gulf of Boothia. It consists of brief descriptions of the field techniques used to collect the data and the analytical methods used during processing. The data are presented in an Appendix at the end of the report.

3544 SANDILANDS, R.G., SOLVASON, R.R., and ST. JACQUES, D.A. (1986)

1985 Tidal Survey in the vicinity of Cameron Island, N.W.T.; Fish. & Oceans, Can. Hydrographic Serv., Burlington, Ont., Data Report, 44 p.

As part of an ongoing project to study tidal propagation in the Arctic Archipelago, the Tides, Currents and Water Levels Section, Central Region, deployed five tides gauges in the vicinity of Cameron Island during 1985. Figure 1 shows the gauge locations and the tidal station numbers assigned to each deployment. Pressure data were collected from March 13 to April 25, 1985.

This report consists of a brief description of the field techniques used to collect the data and the analytical methods used during processing. The data are presented in an Appendix at the end of the report.

3203 WOODS, M.V. (1986)

Horizontal Accuracy of Soundings and the ARGO DM-54; Lighthouse, Edition No. 33, pp. 5-9.

3545 WOODS, M.V. (1986)

C.S.S. John P. Tully multi-disciplinary surveys; Final Field Report, Pacific Region, Beaufort Sea, Fish. & Oceans, Can. Hydrographic Serv., Sidney, B.C., 66 p.

The C.S.S. John P. Tully undertook four main projects in 1986. On the voyage to and from the Western Arctic, GEBCO and Magnetics data were collected; while in the Beaufort Sea, hydrography, two Environmental Protection Service (EPS) dumpsite surveys, and the continuation of Atlantic Geoscience Center (AGC) seismic surveys were carried out.

HYDROLOGY

3546 ADAMS, W.P., and ALLAN, C. (1987)

Aspects of the chemistry of ice, notably snow, on lakes; in Seasonal Snowcovers: Physics, Chemistry, Hydrology, eds. H.G. Jones and W.J. Orville-Thomas, Reidel Publishing, Holland, Vol. 211, pp. 393-466.

Snowcovers which form on water bodies form a considerable proportion of the global snowcover. This chapter is a discussion of the chemistry of snowpacks which develop on lakes and their associated freshwater ice forms and processes. The first part treats the evolution of lake snowcover in the context of the growth and decay of the entire lake cover. The second part provides selected examples of hydrologic and biologic roles of lake cover and the third considers the chemistry of ice-related processes and forms, in general terms. In the last part, specific examples of the chemistry of snow and other ice on lakes are developed. These are based on work on Colour Lake, Axel Heiberg Island, NWT (79°N) and Plastic Lake, Southern Ontario (45°N) and on literature dealing with Char Lake, Cornwallis Island, NWT (75°N) and the Saqvaqjuac Lakes, NWT (63°N).

3547 ALLAN, C., and ADAMS, P. (1986)

Variations in ionic composition between High Arctic lake and land snowpack; in Proc. Annual Eastern Snow Conference, June 6-7, 1985, Montreal, Que., pp. 277-283.

The premelt snowpacks beside and on Colour Lake, Axel Heiberg Island, NWT, proved to be similar in terms of water equivalent and stratigraphy but distinct in terms of concentration of major ions. The base of the lake snowpack showed a marked concentration of most major ions. Because of the distinctive chemical "signature" of Colour Lake, it is evident that the origin of these ions is lake water. It is suggested that the lake water was incorporated into the snow during slushing and white ice formation early in the development of the 1.5 m ice sheet. It is also suggested that the incorporation of lake-derived ions into snowpack may be a normal feature of the white ice forming process. It is apparent in this case because of the distinctive chemistry of the lake and because horizontal, as well as vertical, snow samples were used.

3132 ALLAN, C., SCHIFF, S., PIERSON, D., ENGLISH, M., ECCLESTONE, M., and ADAMS, W.P. (1988)

Solifluction and its influence on vegetation and stream water chemistry in small permafrost basins, Axel Heiberg Island, N.T.W.; in Proc. National Student Conf. on Northern

Studies Assoc. Canadian Univ. for Northern Studies (ACUNS), November 18-19, 1986, Ottawa, Canada, eds. W.P. Adams and P.G. Johnson, pp. 230-252.

3548 BIGRAS, S.C. (1986)

Lake regimes, Mackenzie Delta, N.W.T., 1982 and 1983; Env. Can., Nat. Hydro. Res. Inst., internal report, 63 p.

Research on the hydrological regime of channels and lakes in the Mackenzie Delta and on the importance of break-up to the annual cycle has been limited. The objective of this report is to present the results of 1982 and 1983 field seasons (April to September) dealing with the hydrological regime of the Mackenzie Delta, N.W.T. It highlights the analysis of water level, climatic, and break-up data collected.

The 1982 and 1983 break-ups were different and demonstrated the controlling effect of ice jams on water levels of Delta lakes and channels. The 1982 field season began with a mechanical-type break-up accompanied by high water levels which flooded 95 percent of the Delta. In the spring of 1983, break-up was thermal in nature and was accompanied by low water levels causing flooding of only the outer Delta.

Genetic and physical differences between northern and southern study areas played an important role in the response of lakes to hydrometeorologic conditions, but were less important in the hydrologic cycle of channels. Low-closure lakes and high-closure lakes, because of their closure elevation, did not respond to hydrometeorological conditions as did the connected lakes throughout the open water season. They usually flood during the spring break-up but the unconnected or high perched lakes in the south probably only flood during exceptionally high water years. It was clear by the end of the 1983 field season that the unconnected lakes depend completely on flood waters for replenishment.

Coefficients of variation for channel and connected lake sites indicated that water levels were quite variable during the open water period. Unconnected and closure-type lakes had much lower coefficients of variation. Prior to freeze-up lake water levels returned to within a few centimetres of their annual equilibrium level. This was not the case for channel site water levels which fluctuated annually.

3549 BIGRAS, S.C. (1986)

Floating Ice - River and Lake Ice: lake regimes, Mackenzie Delta, NWT; Ice, No. 80, 1st issue, p. 6.

The interaction between various lake types (unconnected, high-closure, low-closure and connected) and the Delta channel network is being assessed by monitoring water levels at nine sites along the eastern sector of the Delta from April to September. Field measurements of snowpack water equivalents, lake and channel ice thicknesses, and climatic conditions are being observed to establish the importance of break-up to the hydrological regime of the Delta lakes and channels.

3550 BIGRAS, S.C. (1987)

Lake regimes, Mackenzie Delta, N.W.T., 1984; Env. Can., Nat. Hydro. Res. Inst., Scientific Series Contr. No. 87005, 52 p.

Research on the hydrologic regime of lakes and channels located in three study areas along the eastern sector of the Mackenzie Delta, was conducted from April to September, 1984. The investigation included consideration and evaluation of (a) the importance of backwater flooding from ice jams, (b) the processes of inflow, outflow and evaporation, (c) hydrometeorological conditions and (d) physiographic controls.

Ice thickness, snow-pack depth, water levels, discharge and meteorologic data were collected at all three study areas. Temporal variations in lake volumes were calculated and the relative effect of the three dominant hydrologic processes on lake levels were analysed.

In 1984, spring break-up in the Delta was of a mature type. Low water levels and a candled ice cover were not conducive to ice jam formation. Small localized ice jams were observed, none of which remained static for more than a few hours. As a result, flooding was restricted to the mid and outer Delta.

Indications are that without backwater flooding from ice jams, the high perched lakes in the southern Delta would dry-up. Connected and closure-type lakes in the mid and outer Delta are not as likely to suffer the same fate. Connected lakes have a direct low water connection (i.e. distributary channel) and closure-type lakes have a low-closure elevation.

3551 GREGOR, D.J. (1988)

Arctic snow chemistry survey: FY 1987/88, Progress Report; Env. Can., Water Quality Branch, Regina, Sask., internal report, 7 p.

3213 HEGINBOTTOM, J.A., and SINCLAIR, M.P. (1985)

Cumulative Index to Permafrost Conference Proceedings (1958-1983); Geol. Surv. Can., Open File Report 1135, 215 p.

3328 HEGINBOTTOM, J.A., and VINCENT, J-S. (1986)

Correlation of Quaternary deposits and events around the margin of the Beaufort Sea: Contributions from a joint Canadian-American

workshop, April 1984; Geol. Surv. Can., Open File Report 1237, 60 p.

3552 LAPOINTE, M.F. (1986)

Mackenzie Delta channel dynamics: miscellaneous data; Env. Can., Nat. Hydro. Res. Inst., internal report, 12 p.

This report presents miscellaneous data on Mackenzie Delta channel dynamics collected between 1984 and 1986. An updated map of channel shifting rates over the past 20 to 30 years in the Mackenzie Delta, more complete and accurate than a previous version, is presented. As well, a similar but completely new map is presented covering that part of the Outer Delta north of 69°N and east of 136°W (NTS map sheet 107C): it may be of particular use in the eventuality of hydrocarbon extraction and transport over that area. Some data are also presented on bed material textures along a 130 km reach of East Channel, confirming and adding detail to previous findings on a gradual decrease of sand content downstream along a distributary of Middle Channel. Finally, four flood plain surveys are presented which indicate how, in different areas of the Delta, the elevation of laterally accreting flat compares to the elevation of the eroding older spruce-covered bank.

3553 MARSH, P., and WOO, M-K. (1985)

Meltwater Movement in Natural Heterogeneous Snow Covers; Water Resources Res., Vol. 21, No. 11, pp. 1710-1716.

Measurement of flow at the base of Arctic snow covers has shown that over small areas the flow varies from 0 to 240% of the mean surface meltwater flux. This variability in flow is primarily controlled by ice layers in the snow cover and is not caused by vertical flow channels with larger grain sizes. Day-to-day fluctuations in the flow variability were not sensitive to changes in snow depth or the number of ice layers but variations in flow were inversely related to flow volume, with lower variability during high flow days. A multiple-flow path model was developed to route water down independent flow paths, with each path carrying a different portion of the flow. Successful application of this model to data for a number of days from the Canadian Arctic and for 1 day from the Central Sierra Snow Lab suggests that it may be generally applicable to the snow covers in different environments.

3554 MARSH, P. (1986)

Floating Ice - River and Lake Ice: hydrological studies, Mackenzie Delta lakes; Ice, No. 80, 1st issue, p. 6.

A lake hydrology study to determine the relative importance of the processes controlling lake level is continuing in the Mackenzie Delta, N.W.T. The lakes studied include both high- and low-connection lakes. They have a unique and sensitive hydrologic regime since they are underlain by taliks and receive a large input of floodwater during spring break-up when water levels in the Mackenzie River are controlled by ice jamming. Work is continuing on developing a model to predict changes in lake level.

3555 MARSH, P. (1986)

Floating Ice - River and Lake Ice: water temperature beneath river ice covers; Ice, No. 80, 1st Issue, p. 6.

Detailed measurements of water temperature have been made in the ice-covered Liard River, N.W.T. The energy sources controlling water temperature, radiation penetration of the ice, internal friction heat, and bed heat flux have been measured or simulated. A model predicting water temperature, both across the channel and with time, has been developed.

3556 MARSH, P. (1986)

Modelling water levels for a lake in the Mackenzie Delta; in Proc. Cold Regions Hydrology Sym., American Water Resources Assoc., July, 1986, pp. 23-29.

A detailed hydrologic study of a perched lake in the Mackenzie Delta was carried out during the summer of 1985. The hydrologic regime of this lake may be divided into three distinct periods: flooding, discharge, and evaporation. Over the summer of 1985 the lake experienced a small negative water balance. However, if the lake was not flooded, it would have experienced a severe negative balance since evaporation exceeded precipitation. This type of lake is probably dependent on flooding to keep water levels at the present level. A simulation model, which accurately predicted water level over the summer period, could be used to predict the flooding frequency required to maintain lake levels.

3557 MARSH, P. (1986)

Hydrologic Studies - Mackenzie Delta; Env. Can., Nat. Hydro. Res. Inst., Progress Report to PCSP, 21 p.

The primary aim of this study is to determine the processes controlling lake level in a number of representative delta lakes. During 1986 work has concentrated on: (1) determining the magnitude of the water balance components of a moderate sill-elevation lake (NRC Lake), (2) developing a simple, reliable technique for modelling lake evaporation, (3) developing a computer model for predicting lake levels in the moderate and high sill-elevation lakes, (4) measuring flow direction and discharge in the 'reversing' channels connecting the low sill-elevation lakes (Skidoo and

South Lakes) and main channels, and (5) measuring the sill elevation of a large number of lakes.

The hydrologic regime of delta lakes has significant implications to the biological productivity and richness of the delta. In order to improve our understanding of the linkages between the hydrologic and biologic processes we have co-operated with scientists from the Fresh Water Institute in Winnipeg over the last year. A better understanding of the hydrologic regime of these delta lakes is required to understand and limit the environmental impact of future development in the Mackenzie River Basin. This includes, but is not limited to, the building of dams on the Mackenzie River or major tributaries, and the introduction of pollutants into the Mackenzie Basin upstream from the Delta.

3558 MARSH. P., and HEY, M. (1988)

Mackenzie River water levels and the flooding of delta lakes; Env. Can., Nat. Hydro. Res. Inst., Contr. No. 88013, 135 p.

The hydrologic regime of lakes in the Mackenzie Delta is controlled primarily by lake sill elevations and water levels in the Mackenzie River distributing channels. The resulting variations in lake regime have important effects on the water, sediment, and nutrient balance of delta lakes, and therefore on the biologic regime of each lake.

Analysis of 12 to 25 years of Mackenzie River East Channel water levels allowed the documentation of the relationship between flooding regime and sill elevation for lakes in the study area near Inuvik, N.W.T. These data showed that in this portion of the delta, the timing of the spring rise in water levels is very consistent, with peak levels, for example, occurring on June 3 with a standard deviation of only 4 days. The magnitude of the spring flood varies greatly from year to year, and as a result only 67% of lakes in the study area flood annually in the spring, while the remaining lakes have a flood frequency of greater than 1 year and less than 4 years. Since the mean summer flood peak of 2.777 m asl is considerably lower than the mean spring peak of 5.636 m asl, summer lake flooding is not as extensive, with only 20% of lakes receiving floodwater annually during the summer. By late summer, water levels drop to 1.5 m asl annually, cutting off approximately 88% of lakes from the Mackenzie River.

Variations in the hydrologic regime of the Mackenzie River could occur in the future due to hydro-electric development, climate change, or rising sea level. Even small changes in Mackenzie River levels could result in a significant modification to the hydrologic regime of delta lakes. The effects on the viability of these lakes or their chemical and nutrient balances are not well known.

3403 MICHEL, F.A. (1985)

Nature and history of ground ice in the Yukon - Isotope Investigations, Carleton Univ., Report to Energy, Mines & Resources, Earth Physics Br., 135 p.

3559 SHERSTONE, D.A. (1986)

Ice thickness in the Mackenzie Delta, winter 1985-86; Ind. & Northern Affairs, Inuvik Scientific Resource Centre, Inuvik, N.W.T., Report No. 86-1, 15 p.

The ice monitoring program in 1985-86 was similar to those of the past several winters. Favourable weather conditions allowed early installation of all gauges. The first gauge was installed on East Channel, in front of the Town of Inuvik, on October 24, by which time the ice had attained a thickness of 19 cm. The last gauges were installed on West Channel on December 5th, about one month sooner than in the 1984-85 winter.

Reading of gauges continued throughout the winter and terminated on June 1, at which time the gauges were removed. As a result, the 85-86 winter represents the longest record of ice growth and decay in the study, approximately two months longer than previous records.

Despite the length of the winter the maximum thicknesses reached were generally less than those achieved in the 1983-84 and 1984-85 winters. This was due, in large part, to the relatively mild winter in the Delta.

3560 WOO, M-K. (1986)

Permafrost Hydrology in North America; Atmosphere-Ocean, Vol. 24, No. 3, pp. 201-234.

This paper reviews hydrologic processes in the permafrost regions of northern North America. Much work has recently been done at specific experimental plots to parallel the progress in laboratory investigations, improving our understanding of the heat and water fluxes in thawed and frozen grounds, infiltration in frozen soils, evaporation in a cold environment, interaction between snow and its frozen substrate, and the dynamics of storage in the active layer. Field research on permafrost slopes and in northern research basins adds to our knowledge of permafrost groundwater hydrology, runoff generating processes, river freeze-up and breakup processes and allows more precise definition of basin water balance. Sufficient hydrometric data are now available to analyse the streamflow characteristics in an area with permafrost, and more work should be done along this line. It is urged that process studies be continued to gain a better understanding of the effect of permafrost upon the hydrologic cycle. Further research is needed to

predict the impacts of human activities on the movement and redistribution of water.

3561 WOO, M-K. (1986)

Floating Ice - River and Lake Ice: break-up of small streams; Ice, No. 80, 1st Issue, p. 6.

The effects of snow and ice upon spring floods in small subarctic streams have been studied. These processes typically involve the clearance of snow and ice in the channels and frequent exchanges of water flow between the streams and their adjacent wetlands during the break-up.

3562 WOO, M-K. (1986)

Runoff Regime of Slopes in Continuous Permafrost Areas; Can. Water Resources J., Vol. 11, No. 1, pp. 58-68.

The hydrological regime of slopes underlain by continuous permafrost is dictated by the seasonal differences in the supplies of water and energy. Based on a study at Resolute, N.W.T., three hydrological seasons are recognized. In winter, the ground freezes, snow accumulates, and most hydrological activities on the slopes are dormant. As energy supply increases in spring, snowmelt generates considerable runoff but frozen ground restricts subsurface water movement and surface flow prevails. Summer runoff declines as the slopes become snow-free and as evaporation increases. Rainfall is often of low magnitude though occasional storms of high intensity can rejuvenate surface flow.

Spatial variation in slope runoff is conspicuous. Areas below deep snowpacks or at the base of concave slopes receive abundant water supply throughout most parts of the thaw season. Otherwise, the grounds become dry soon after the melt period. It is recommended that construction works in the High Arctic should not be carried out in spring when most slopes are saturated, and that areas with surface flow should be avoided in the summer season.

3563 WOO, M-K., and DUBREUIL, M-A. (1983)

Effects of an Arctic settlement on the snowpack; in Proc. 40th Annual Meeting, Eastern Snow Conference, Vol. 28, Toronto, Ontario, June 2-3, 1983, Vol. 28, pp. 143-156.

Research was carried out in 1981 to study the effects of a northern settlement on the arctic snowpack. A comparison of the snow cover in and outside the airport area of Resolute in the Northwest Territories shows that: (1) the snow distribution pattern was affected by the presence of buildings and by snow removal operations; (2) the emission of pollutants from dwellings and from the power plant contaminated the snow with trace metals; (3) the dust load on the snow was greatly increased within the settlement and this considerably reduced the snow surface albedo; (4) with a reduction in albedo, the radiation balance was changed and it was possible to estimate the net radiation as an empirical function of the albedo and the incoming short-wave radiation; (5) a contrast in the radiation balance was responsible for an accelerated melt rate near the human settlement.

Field observation and transects extending outward from Resolute showed that the anthropogenic effects diminish sharply away from the human settlement, suggesting that the influences are localized.

ICE ISLAND

3496 ASUDEH, I., FORSYTH, D.A., JACKSON, H.R., STEPHENSON, R., and EMBRY, A. (1988)

The Ice Island refraction surveys; Abstract in, Proc. GAC, MAC, CSPG Joint Annual Meeting, May 23-25, 1988, St. John's, Newfoundland, Program with Abstracts, Vol. 13, p. A4.

3564 CHRISTIE, R.L., HOBSON, G.D., and LAPOINTE, P. (1988)

Canadian Ice Island Research Program - an opportunity; Abstract in, Proc. GAC, MAC, CSPG Joint Annual meeting, May 23-25, 1988, St. John's, Newfoundland, Program with Abstracts, Vol. 13, p. A20.

In 1984, PCSP established a research station on an Ice Island, presently located northwest of Ellef Ringnes Island at 107°W, 80°N; this Ice Island has been moving along Canada's shelf in shallow waters since it was occupied by Canada. Whereas restricted movement of the Ice Island and limited resources have precluded a major general scientific program and major infrastructure investment, important first order geophysical and geological programs have been executed from 1985 to 1987. In December 1987, the Ice Island moved more than 110 km in a southwesterly direction to deeper water from where Canada Basin current may move the Island along the Canadian continental slope into United States, international, and eventually Soviet waters.

Given political, economic, sovereignty and scientific benefits, as well as defence implications, the Ice Island represents a unique opportunity for Canada to exercise its sovereignty over the Canadian sector of the Arctic and continue its leadership in Arctic science. PCSP foresees the need to establish, manage, and coordinate a full-scale, multi-agency, multidisciplinary scientific program on the Ice Island which should include international collaboration of circumpolar countries. PCSP will highlight the present infra-

structure, present and future scientific programs and challenges.

3499 COX, T.P., MEREU, R.F., and OVERTON, A. (1988)

Seismic reflection results from an ice island over the Arctic Continental Shelf; Abstract in, Proc. GAC, MAC, CSPG Joint Annual Meeting, May 23-25, 1988, St. John's, Newfoundland, Program with Abstracts, Vol. 13, p. A27.

3502 HAJNAL, Z., and OVERTON, A. (1988)

Reflection survey on Hobson's Choice Ice Island, Arctic Ocean; Abstract in, Proc. GAC, MAC, CSPG Joint Annual Meeting, May 23-25, 1988, St. John's, Newfoundland, Program with Abstracts, Vol. 13, p. A50.

3565 HOBSON, G.D. (1986/87)

PCSP's Floating Research Station; Arctic Petroleum Review, Vol. 9, No. 2, p. 6.

3566 JACKSON, R. (1986)

Ice island lab shows petroleum potential; GEOS, Energy, Mines & Resources, Vol. 15, No. 2, pp. 1-4.

Working from an island of ice in the Arctic Ocean, researchers have found a significant amount of unconsolidated sediment and sedimentary rock on the last unexplored ocean floor within Canadian waters. This confirms earlier suspicions; there is a potential for oil and gas in the very high Arctic.

3345 JACKSON, H.R. (1988)

A seismic stratigraphy for the polar margin; Abstract in, Proc. GAC, MAC, CSPG Joint Annual meeting, May 23-25, 1988, St. John's, Newfoundland, Program with Abstracts, Vol. 13, p. A60.

3526 JEFFRIES, M.O. (1986)

Glaciers and the morphology and structure of Milne Ice shelf, Ellesmere Island, N.W.T., Canada; Arctic & Alpine Res., Vol. 18, No. 4, pp. 397-405.

3527 JEFFRIES, M.O. (1986)

Ice Island Calvings and Ice Shelf Changes, Milne Ice Shelf and Ayles Ice Shelf, Ellesmere Island, N.T.W.; Arctic, Vol. 39, No. 1, pp. 15-19.

3567 JEFFRIES, M.O. (1987)

The growth, structure and disintegration of Arctic ice shelves; Polar Record, Vol. 23, No. 147, pp. 631-649.

The north coast of Ellesmere Island is the location of the only known ice shelves in the northern hemisphere. Present Arctic ice shelves are as much as 40-50 m thick and occupy sheltered fiords and embayments. These thick floating ice masses are remnants of the once-extensive Ellesmere Ice Shelf that has disintegrated since 1876-1906, when Aldrich and Peary respectively travelled along the coast. Reasons for the disintegration are not clear, but it has created many ice islands that have been known to circulate in the Arctic Ocean for 35 years or more. Both ice islands and ice shelves are readily distinguished from their surroundings by an undulating surface topography of parallel ridges and troughs up to 300 m apart. The undulations probably owe their origin to the effects of wind and meltwater. Since 1952 these large ice masses have been the subject of considerable research. Ice shelf growth began about 4000 BP, when glaciers flowed off the land and remained afloat in fiords and inlets, and sea ice grew thick and remained fast to the coast. The glacier and sea ice acted as platforms for further thickening both by surface accumulation of snow and ice and by undersurface accretion of fresh, brackish and saline ice. Although much has been learned about the growth, structure and behaviour of arctic ice shelves, questions still remain concerning ice island calving mechanisms, bottom freezing, thick sea ice growth and origins of the ridges and troughs.

3197 JEFFRIES, M.O., and KROUSE, H.R. (1984)

Arctic ice shelf growth, fiord oceanography and climate; Band, Vol. 20, Universitätsverlag Wagner, Innsbruck, pp. 147-153.

3506 LOUDEN, K.E. (1988)

Marine heat flow observations on the Arctic Continental Shelf; Abstract in, Proc. GAC, MAC, CSPG Joint Annual Meeting, May 23-25, 1988, St. John's, Newfoundland, Program with Abstracts, Vol. 13, p. A75.

3407 MUDIE, P.J., HEIN, F.J., and VAN WAGONER, N.A. (1988)

Marine geology studies of sediments on the Canadian Polar Margin; Abstract in Proc. GAC, MAC, CSPG Joint Annual Meeting, May 23-25, 1988, St. John's, Newfoundland, Program with Abstracts, Vol. 13, p. A88.

3568 SACKINGER, W.M., and JEFFRIES, M.O. (1985)

Arctic ice island and sea ice movements and mechanical properties; Univ. Alaska, Fifth Quarterly Report, October 1-December 31, 1984, submitted to U.S. Dept. of Energy, 63 p.

This research program includes the study of the generation and trajectories of ice islands, which are large floating tabular icebergs found in the Arctic Ocean. These are released at sporadic intervals from the ice shelves off the north coast of Ellesmere Island, and pose the most serious hazards which must be taken into account by the designers of Arctic offshore oil and gas production structures. This comes about because of their thickness, which may vary from 10 meters to as much as 60 meters, and because of their transverse dimensions ranging from 500 meters to as much as 34 kilometers. As they drift along the coast of the Alaskan Beaufort Sea, they sweep through the area which is likely to include the producing regions for offshore oil and gas. The force of the pack ice behind the ice island, driving against it, can increase to large values if the island is stopped by collision with an offshore structure, and the large mass of the ice island (up to 10^{10} tons) itself will deliver a high impulsive force when the ice island interact with an offshore structure.

3569 SACKINGER, W.M., JEFFRIES, M.O., YAN, M. and TIPPENS, M. (1986)

Ice Islands, Ice, No. 80, 1st issue, p. 18.1

In September 1985, a 42-m ice core was drilled through an ice island that calved from eastern Ward Hunt Ice Shelf, Ellesmere Island, Canada during the interval 1982-83. Subsequent analysis has shown that the entire ice column is composed of non-saline ice. This is quite unlike western Ward Hunt Ice Shelf where there is a large body of old sea ice in the shelf.

Ice island drift is being monitored by satellite telemetry. Selected ice island trajectories are being related to meteorological data. In addition, a computer model of ice island movement is being developed.

3455 SCHRÖDER, C.J., MEDIOLI, F.S., and COLE, F.E. (1988)

Benthic foraminifera of Arctic environments: ice island versus Lancaster Sound; Abstract in, GAC, MAC, CSPG Joint Annual Meeting, May 23-25, 1988, St. John's, Newfoundland, Program with Abstracts, Vol. 13, pp. A109-A110.

2994 SOBCZAK, L.W., and WEBER, J.R. (1987)

Gravity and bathymetry taken along seismic refraction lines from the Canadian Ice Island during 1985 and 1986; in Current Research, Part A, Geol. Surv. Can., Paper 87-1A, pp. 299-304. Ice Island Contr. No. 10.

3508 SOBCZAK, L.W., and HALPENNY, J.F. (1988)

Gravity anomaly maps of the Arctic (Free-Air, Bouguer, Total Isostatic, Residual Isostatic and Sobczak); Abstract in, Proc. GAC, MAC, CSPG Joint Annual Meeting, May 23-25, 1988, St. John's, Newfoundland, Program with Abstracts, Vol. 13, p. A114-115.

2995 VAN WAGONER, N.A., DABORN, G., and MUDIE, P. (1986)

Recent Arctic "Reefs"; Abstract in GAC, MAC, CGU-AGC, AMC, UCG Joint Annual Meeting, Program of Abstracts, Vol. 11, Carleton Univ., Ottawa, Ontario, May 19-21, 1986, p. 140.

3570 YAN, M-H. (1986)

The relationship between ice island movement and weather conditions; Univ. Alaska, Project Report submitted to U.S. Dept. of Energy, Contract No. DE-AC21-83M20037, 91 p.

The object of this study is to find the relationship between ice island movement and synoptic weather conditions by using daily ice island position information and surface pressure maps. Trajectory analysis of an ice island for one year shows three types of movement episodes: (1) large movement in the southwest direction, (2) medium movement in two sequentially opposite directions and (3) small random movement. Surface pressure maps show that an off-shore geostrophic wind component is a necessary pre-condition for the large and medium movements in the southwest direction. A high pressure system located near the North Pole then causes the movement in the southwest direction, whereas a low pressure system located near the North pole causes the movement in the northeast direction.

Results show that the speed ratios between the ice island and the geostrophic wind range from 1.0% to 1.5% for the large movement and 0.1% to 1.0% for the medium movement; the average angle ranges from 20 to 26 degrees counter-clockwise from the geostrophic wind direction to the ice island movement direction. A force balance shows that, for an equilibrium drifting state, a residual force must be included.

ICE PHYSICS

3571 ADAMS, W.P. (1986)

Floating Ice - River and Lake Ice: chemistry of lake ice; Ice, No. 80, 1st issue, p. 6.

Studies of the ice, including snow, cover of lakes in northern Quebec-Labrador and on Colour Lake, Axel Heiberg Island, N.W.T., continued. These focussed on aspects of the chemistry of the ice and the lakes.

3572 HERON, R. (1985)

Decay of a High Arctic Lake Ice Cover; unpub. Ph.D. thesis, McMaster Univ., 189 p.

This is a study of the decay processes of an ice cover on a small Arctic lake. The study was carried out near Resolute, N.W.T., Canada, for two melt seasons commencing in late May prior to melt and continuing until the lake was ice-free in late July. During this period, ice thickness, other ice properties and melt from the upper and lower ice surfaces were measured regularly. In addition, environmental conditions which affect the melt rate, such as air and water temperature and net radiation were obtained to permit a computation of the energy balance for the ice.

A one-dimensional energy balance model used to calculate the ice melt at a site performs well in predicting the ablation from the upper ice surface, melt from the lower ice surface and the internal melt and ice density. For the two study years, 49 percent of the melt (in water equivalent units) occurred in the ice interior due to absorbed radiation while ice melt at the upper ice surface (in water equivalent) amounted to 40 percent. Melt at the lower ice surface was only 11 percent of the total ice melt. Seventy five percent of the change in ice thickness occurred at the upper ice surface where much of the internal ice melt was concentrated, producing low surface ice densities.

The formation of a moat along the edge of the ice cover and its subsequent growth was investigated. The results were incorporated in a two-dimensional model of ice decay along a transect normal to the shore. A series of transects allowed a simulation of the behaviour of the entire ice cover. The modelled results agree closely with the observed ice decay events from the beginning of melt until the fragmentation of the ice cover. Although the ice decay period was emphasized, the two-dimensional model can be expanded to include the season of ice growth.

ICE SHELVES

3526 JEFFRIES, M.O. (1986)

Glaciers and the morphology and structure of Milne Ice shelf, Ellesmere Island, N.W.T., Canada; Arctic & Alpine Res., Vol. 18, No. 4, pp. 397-405.

3573 JEFFRIES, M.O., and KROUSE, H.R. (1986)

Ice Physics/Engineering: chemical analysis of ice cores; Ice, No. 80, 1st issue, p. 12.

In April and May 1985, fieldwork on the north coast of Ellesmere Island involved sea ice coring and stratified lake sampling. Ice cores were drilled in adjacent ridges and troughs in multi-year landfast sea ice at the front of Ward Hunt Ice Shelf, Milne Ice shelf and in Ayles Fiord. Ice salinity has been measured and O^{18} and tritium analysis is being undertaken to study the processes of thermo-dynamic sea ice growth and ice shelf regeneration. Stratified Lake "C" has remained stratified since it was last investigated in 1969. A second stratified lake was discovered 3 km south of Lake "C". Isotopic investigations of these lakes are in progress to assess their paleoclimatological significance and study microbiological sulphate reduction and oxidation of organic matter at high latitudes.

3574 JEFFRIES, M.O., SACKINGER, W.M., and SERSON, H.V. (1987)

Remote sensing of sea-ice growth and melt-pool evolution, Milne Ice Shelf, Ellesmere Island, Canada; Annals of Glaciology, Vol. 9, pp. 145-150.

Periodically since 1950, air photographs and SLAR images have been taken of the Arctic ice shelves. The study of air photographs and SLAR images of the outer part of the Milne Ice Shelf had three aims: (1) to map losses and ice re-growth at the shelf front, (2) to map the evolution of melt pools on shelf ice and multi-year land-fast sea ice, and (3) to assess the usefulness of air photographs and SLAR for these purposes. For mapping of ice calvings and subsequent sea-ice growth, both air photographs and radar images have been used successfully. However, air photographs are better than radar for mapping ice-surface features. The ridge-and-trough systems that characterize the surface of the ice shelf and old sea ice are clearly visible on each type of imagery but, because of their larger scale, air photographs proved to be most useful for a study of melt-pool evolution. The orientation of the melt pools is parallel to the prevailing winds which drive water along the troughs. The drainage system evolves by a process of elongation and coalescence.

3575 MacAYEAL, D.R., and HOLDSWORTH, G. (1986)

An investigation of low-stress ice rheology on the Ward Hunt Ice Shelf; J. Geophys. Res., Vol. 91, No. B6, pp. 6347-6358.

Deformation of the Ward Hunt Ice Shelf, Northwest Territories, Canada, can be used to study the rheology of ice in the low-stress, low-strain rate regime ($10^{-12}s^{-1}$). Finite element simulations are

separately displayed to demonstrate what the effects of ice salinity, ice temperature, and sea-ice back pressure have on the spreading rates of this ice shelf. We conclude that in general these effects tend to obscure any differences between the commonly used non-Newtonian flow law and the Newtonian flow law recently reinterpreted from field measurements. The numerical simulations indicate that there are specific locations where useful field measurements could be carried out on the ice shelf.

LIMNOLOGY

3576 ADAMS, W.P. (1987)

Northern Limnological Processes: Research and Management; in Arctic Heritage, eds. J.G. Nelson et al., Assoc. of Canadian Universities for Northern Studies (ACUNS), Ottawa, Ontario, pp. 112-146.

Information and ideas on northern lakes are important for those interested in ecological, planning and management aspects of arctic heritage use and conservation. In many northern areas, lakes form a dominant feature of the landscape, in others they are relatively rare. In both of these cases, the lakes form a critical feature of the physical and biological systems of the region concerned.

Although arctic lakes are ice-covered for most of the year, more is known about their ice-free condition. In this paper there is a deliberate emphasis on conservation and management implications of lake ice, including snow cover.

3547 ALLAN, C., and ADAMS, P. (1985)

Variations in ionic composition between High Arctic lake and land snowpack; in Proc. Annual Eastern Snow Conference, June 6-7, 1985, Montreal, Que., pp. 277-283.

3577 DICKMAN, M. (1987)

Garrow Lake, Canada's most northerly meromictic, hypersaline lake; Abstract in, The Canadian Arctic Islands, Canada's Missing Dimension, Nov. 21-24, 1987, Ottawa, Canada, Nat. Museum of Natural Sciences, Program and Abstracts, p. 40.

Garrow Lake is ice covered during 11 months of the year, with ice reaching 2.4 m in thickness. The lake, with an area of 418 ha and a maximum depth of 47 m, was once connected to the sea as a fiord located near the southern tip of Little Cornwallis Island. Isostatic uplift isolated Garrow Lake from the sea about 3,000 yr B.P. Isotope dating indicates that the bottom waters of the lake (20-47 m deep monimolimnion) have been stagnant and hypersaline (7.5%) for nearly 2,500 years.

The lake is thermally stratified as a result of its salinity-density gradient and solar heating. The water at 20 m has a fairly constant temperature of 8.9-9.1°C. Salinity varies from less than 0.1% at the surface to 7.5% at the lake's bottom. The ionic composition of these salts is similar to that of seawater.

Biotic diversity is low. The chemocline (19-20 m) is colonized by a curious group of photosynthetic (phototrophic) bacteria that are grazed by only one species of crustacean, the copepod Limnocalanus macrurus. Only one vertebrate inhabits the lake, the fourhorn sculpin, Myxocephalus quadricornis, and only 51 taxa of phytoplankton have been identified to date from this High Arctic lake.

In November 1981, COMINCO began discharging approximately 100 tonnes/hr of lead and zinc mine tailings into Garrow Lake. The impact of these tailings on the natural biota of Garrow Lake was the focus of this study.

3026 DICKMAN, M., and OUELLET, M. (1987)

Limnology of Garrow Lake, NWT, Canada; Polar Record, Vol. 23, No. 146, pp. 531-549.

3578 DOUGLAS, M.S.V., and SMOL, J.P. (1987)

Siliceous protozoan plates in lake sediments; Hydrobiologia, Vol. 154, pp. 13-23.

The silicified plates of certain testate amoebae have the necessary characteristics to be useful paleoindicators. These plates are usually abundant and well preserved in sedimentary deposits, where they can be studied using the same preparation techniques developed for other siliceous microfossils. Individual plates can usually be identified to the generic and, in some cases, to the species level. A preliminary survey of plates recorded in the surficial (top centimetre) sediments of 38 Adirondack Mountain (NY) lakes suggests that these testaceans may reflect catchment features (e.g. bog development) more closely than lakewater characteristics. The siliceous, species-specific scales of heliozoans are also shown to preserve in sedimentary profiles.

3572 HERON, R. (1985)

Decay of a High Arctic Lake Ice Cover; unpub. Ph.D. thesis, McMaster Univ., 189 p.

3579 JEFFRIES, M.O., and KROUSE, H.R. (1985)

Isotopic and chemical investigations of two stratified lakes in the Canadian Arctic; Band, Vol. 21, pp. 71-78.

Isotopic and chemical data for two stratified lakes on northern Ellesmere Island, Canada, provide proxy historical records of their physical and biological changes. Tritium generated during thermonuclear bomb tests, is concentrated within a short depth interval in the surface freshwater layer whereas natural background levels are found in the underlying seawater. In contrast, the depth profiles of ion concentrations and isotopic compositions of water appear consistent with long term ($\sim 10^3$ years) diffusion phenomena. Quantitative analyses of the depth profiles using diffusion equations are complicated by a pronounced temperature maximum in the freshwater-seawater transition zone and

by bacterial conversions of some ions e.g. SO_4^{2-} and HCO_3^-. However, the extent of microbiological SO_4^{2-} reduction and associated isotopic fractionation per se provide information concerning the relative chronologies of these lakes.

3580 OUELLET, M., BISSON, M., PAGÉ, P., and DICKMAN, M. (1987)

Physicochemical limnology of meromictic saline Lake Sophia, Canadian Arctic Archipelago; Arctic & Alpine Res., Vol. 19, No. 3, pp. 305-312.

The basic physicochemical characteristics of a Canadian High Arctic deep meromictic and mesothermic lake with an open drainage system are presented. The monimolimnetic salinity of Lake Sophia reaches 58°/oo and its mid-water temperature is perennially at 12°C. This type lake is most commonly found in Antarctica, while so far only two have been reported from the Canadian Arctic.

The salts of the monimolimnion seem to have originated during the postglacial marine submergence mainly from marine waters trapped within the ancient lake basin and beneath the surface of the area. It is most likely that the concentration of salts by freezing-out of ions from the underground relict pore seawater was progressively brought about by the encroachment of permafrost on the newly uplifted lake surrounding. The water insulating layer could have caused the formation of a talik beneath the lake basin, which subsequently favored the displacement of the underground saline water toward the bottom of the lake. With time, some of the underground inflowing waters would have migrated to the mixolimnion, there to be diluted with slightly mineralized meteoric waters before leaving the lake through the outflowing creek.

3228 PAGÉ, P., OUELLET, M., HILLAIRE-MARCEL, C., and DICKMAN, M. (1984)

Isotopic analyses (^{18}O, ^{13}C, ^{14}C) of two meromictic lakes in the Canadian Arctic Archipelago; Limnol. Oceanogr., Vol. 29, No. 3, pp. 564-573.

3229 PAGÉ, P., MICHAUD, J., OUELLET, M., and DICKMAN, M. (1987)

Isotopic composition and origin of lacustrine brines in the Arctic; Can. J. Earth Sci., Vol. 24, pp. 210-216.

3167 RITCHIE, J.C. (1976)

The Campbell Dolomite Upland Near Inuvik, N.W.T. A Unique Scientific Resource; Musk-Ox, Vol. 18, pp. 70-75.

LOREX

3406 MORROW, D.W., and KERR, J.W. (1986)

Geology of Grinnell Peninsula and the Prince Alfred Bay area, Devon Island, District of Franklin, N.W.T.; Geol. Surv. Can., Open File 1325, GSC List 951, 45 p.

3202 QUEK, S.H. (1983)

Spline smoothing of two-dimensional data series with precision estimation applied to satellite navigation; Univ. New Brunswick, Dept. Surveying Engineering, Tech. Rep. No. 101, 271 p. LOREX Contr. No. 19.

OCEANOGRAPHY

3581 APOLLONIO, S. (1988)

Chelation of Arctic Water by sea-ice Algae; Final Report to National Geographic Society, Washington, D.C., Grant No. 3294-86, 22 p.

Arctic marine phytoplankton photosynthetic rates were stimulated by an artificial chelator (EDTA) and by a trace metal solution. This stimulation was imitated by extracts from sea ice containing high concentrations of dissolved organic carbon (DOC). These results support the hypothesis that DOC produced in association with sea ice algae acts as a chelator in arctic waters.

3007 BATES, S.S., and COTA, G.F. (1986)

Fluorescence induction and photosynthetic responses of Arctic ice algae to sample treatment and salinity; J. Phycol., Vol. 22, pp. 421-429.

3582 BUCKLEY, J.R., DE LANGE BOOM, B.R., and REIMER, E.M. (1987)

The Physical Oceanography of the Cape Hatt Region, Eclipse Sound, N.W.T.; Arctic, Vol. 40, Supp. 1, pp. 20-33.

In the spring and summer of 1980 and 1981, detailed measurements of water temperature, salinity and depth, currents, tidal height and waves were made in the vicinity of Cape Hatt, at the northern end of Baffin Island, N.W.T., in support of the Baffin Island Oil Spill (BIOS) Project. Currents in the region were generally weak, averaging less than 10 $cm \cdot s^{-1}$ near the surface and about 2 $cm \cdot s^{-1}$ in the deeper waters. Deep circulation in Ragged Channel, on the western side of Cape Hatt, was usually counterclockwise. On the western side of Cape Hatt, a strong (up to 30 $cm \cdot s^{-1}$) northward flowing coastal current existed. It was occasionally reversed by a flood tide or prolonged south winds. Eddies were observed in bays on the western side of Cape Hatt driven by this coastal current. These eddies were clockwise when the flow offshore was northward and counterclockwise when the flow was southward. Evidence was found for an internal M_2 tide in Ragged Channel. Some of the variations in the observed currents and density fields were explained with a simple model of this tide. Under-ice density profiles showed a typical well-mixed layer just above freezing temperature that reached to the bottom in the nearshore regions and to about 35 m depth in mid-channel. In the ice-free season, there was a pronounced shallow mixed layer that ranged from 4 to 10 m in depth. Water properties at the bottom of Ragged Channel were essentially unchanged from winter to summer. In the winter, water properties in Z-Lagoon were similar to those in Ragged Channel. In the summer, they showed the result of being cut off from the main body of Eclipse Sound. In Ragged Channel, wave conditions were very mild, not exceeding 20 cm in significant height, while on the eastern side of Cape Hatt, they were worse, up to 1.4 m, but still not severe.

3014 BUTLER, J.E. (1985)

Phytoplankton ecology in a High Arctic polynya; unpub. M.Sc. thesis, Civil Engineering Dept., Univ. British Columbia, 105 p.

3021 CONOVER, R.J. (1988)

Comparative life histories in the general Calanus and Neocalanus in high latitudes of the Northern Hemisphere; Hydrobiologia, Vol. 167-168, pp. 127-142.

3022 CONOVER, R.J., BEDO, A.W., and SPRY, J.A. (1988)

Arctic zooplankton prefer living ice algae: a caution for zooplankton excretion measurements; J. Plankton Res., Vol. 10, No. 2, pp. 267-282.

3023 CONOVER, R.J., HERMAN, A.W., PRINSENBERG, S.J., and HARRIS, L.R. (1986)

Distribution of and Feeding by the Copepod Pseudocalanus Under Fast Ice During the Arctic Spring; Science, Vol. 232, pp. 1245-1247.

3025 COTA, G.F., PRINSENBERG, S.J., BENNETT, E.B., LODER, J.W., LEWIS, M.R., ANNING, J.L., WATSON, N.H.F., and HARRIS, L.R. (1987)

Nutrient Fluxes During Extended Blooms of Arctic Ice Algae; J. Geophys. Res., Vol. 92, No. C2, pp. 1951-1962.

3583 GREISMAN, P., GRANT, S., BLASKOVITCH, A., and van HARDENBERG, B. (1986)

Tidal propagation measurements in Baffin Bay, Lancaster Sound and Nares Strait; Fish. & Oceans, Can. Contract. Rep. Hydrogr. Ocean Sci., No. 25, 556 p.

We deployed twenty-nine tide gauges and five current meters through the sea ice along the east coast of Baffin Island, in Lancaster Sound and in Nares Strait during late February and recovered them in late April of 1985. Most of the instruments collected data of good quality. In addition we report here on three tide gauges deployed by the Bedford Institute and in place for over one year. Subsequent harmonic analyses of tidal constituents show that the tides are mainly semi-diurnal in character with ranges up to about 7 m. Tidal currents measured in Nares Strait reached velocities up to 50 cm/s.

Cotidal charts constructed using all available data show that the tides enter Baffin Bay from the south through Davis Strait and progress along the eastern shore and around the bay counter clockwise, propagating westward into Lancaster Sound. In Nares Strait, the tides enter from both the south through Smith Sound and from the Lincoln Sea to the north to form a nearly standing wave in Kane Basin.

3528 JEFFRIES, M.O., and KROUSE, H.R. (1984)

Isotope geochemistry of stratified water bodies on northern Ellesmere Island, Canadian Arctic, in Berichte des Zentralinstituts für isotopen-und strahlenforschung, Akademie der Wissenschaften der DDR, Leipzig, Vol. 84, pp. 159-169.

3584 LANGLEBEN, M.P. (1985)

Oceanic heat flux as a component of the heat budget of sea ice; Annals of Glaciology, Vol. 6, pp. 171-173.

Heat budget studies of the sea ice cover near Pond Inlet, N.W.T., were made using data obtained at two locations in Eclipse Sound, one about 0.5 km from shore and the other about 7.5 km from shore. The observations at intervals of one week included ice temperatures at 10 cm separation in vertical profile, salinities of adjacent 2.5 cm-thick slices from vertical ice cores, and ice thickness. The time series analysed extend from three to six months in the six data sets obtained for three winters of observations. Values of oceanic heat flux have been determined as residuals in the energy balance equation applied to the ice cover. The results show that in Eclipse Sound the oceanic heat flux is a significant component of the heat budget of the ice cover. Its value over the winter is typically about 6 W m^{-2}, about half as large as the average rate of release of the latent heat of freezing. There does not appear to be any systematic variation in value of the 4 week-average oceanic heat flux during the season. Nor is there any apparent correlation of oceanic heat flux with rate of release of latent heat (ie. ice growth rate), or with the severity of the winter as measured by the magnitude of the conductive heat flux.

3585 MACDONALD, R.W. (1976)

Distribution of Low-Molecular-Weight Hydrocarbons in Southern Beaufort Sea; Environmental Science & Technology, Vol. 10, No. 13, pp. 1241-1246.

Seawater concentrations of C_1-C_4 hydrocarbons were measured in the summers of 1974 and 1975 in the Southern Beaufort Sea continental shelf region. In general, there was good agreement between the levels of methane found in the surface waters of the Beaufort Sea and those found in similar environments by others. A few high methane concentrations were found, especially near the bottom, and were attributed to seepage from the sediments. C_2-C_4 saturated hydrocarbon concentrations were low, in contrast to other shelf areas where extensive shipping, ballast tank dumping, and drilling have occurred. Consequently, their concentrations could serve as useful indicators of deterioration of water quality in this area by future shipping or drilling activities. Unsaturated C_2-C_4 hydrocarbon concentrations tended to be somewhat lower than those reported for other oceanic regions, possibly a consequence of low biological productivity in the shelf area at that time of year.

3538 MACDONALD, R.W., WONG, C.S., and ERICKSON, P.E. (1987)

The Distribution of Nutrients in the Southeastern Beaufort Sea: Implications for Water Circulation and Primary Production; J. Geophys. Res., Vol. 92, No. C3, pp. 2939-2952.

3586 PRINSENBERG, S.J., and BENNETT, E.B. (1987)

Analysis of current time series and current profile data from Peel Sound, Canadian Arctic; Fish. & Oceans, Can. Tech. Rep. Hydrogr. Ocean Sci. No. 102, 108 p.

This report presents the analysis of current meter and current profile data collected during March and April of 1981 at the northern entrance to Peel Sound which enters Barrow Strait. The data indicate that part of the eastward circulation in Barrow Strait moves southwards along the western shore of Peel Sound before moving across and joining the northward moving water along the eastern shore. The northward transport occurred at a rate of 17.0 x 10^4 m^3 s^{-1}, about a third of the total expected eastward transport for April in Barrow Strait. Long term variations in currents and transport rates are about 25% of their mean and are caused by atmospheric pressure gradient variation along the Northwest Passage. The semidiurnal tidal currents dominated the shorter period current signal and ranged from 10 to 35 cm s^{-1}. The boundary layer under the ice-cover affects the tidal currents in the same way as the bottom boundary layer. The currents are reduced and the direction of rotation of the current vector changes from a clockwise direction at mid-depth to a counterclockwise direction in the surface and bottom frictional boundary layers.

3452 SCHAFER, C.T., and COLE, F.E. (1985)

Marginal marine foraminifera assemblages in three east coast Baffin Island fiords; Abstract in, 14th Arctic Workshop, Arctic Land-Sea Interaction, Nov. 6-8, 1985, pp. 211-212.

3587 STEFFEN, K. (1985)

Warm Water Cells in the North Water, Northern Baffin Bay during Winter; J. Geophys. Res., Vol. 90, No. C5, pp. 9129-9136.

Sea surface temperatures above the freezing point of seawater (-1.8°C) were observed in the North Water during winter and early spring. The result indicates a possibility of upwelling warm water, presumably of Atlantic origin, brought from lower depths to the surface. The warm water temperatures ranged from -1.7° to -0.1°C. The highest occurrence frequency lay in the temperature interval from -1.0°C to -0.8°C. Most warm water cells were found along the Greenland coast in Smith Sound, Lady Ann Strait, and Barrow Strait. They occurred most frequently in Smith Sound, west of Cape Alexander. The highest temperatures of -0.1°C occurred, however, south of Cape Alexander. The occurrence frequency and the total area of warm water patches decreased toward spring. The predominantly northerly wind that is channeled in Smith Sound accounts for a mean ice drift of approximately 17 km d^{-1}. This ice drift causes an

ice divergence in Smith Sound and along the Greenland coast. The existence of warm water areas can be explained by the strong northerly wind resulting in a Coriolis force that induces coastal upwelling. The wind-induced offshore transport of 3.5 x 10^5 m^3 s^{-1} in the North Water, compensated by the upwelling of Atlantic Baffin Bay water (0°C) along the Greenland coast, will suffice to keep 10% of the North Water ice free. The combination of ice divergence and forced convection of warm water can be considered as a prime cause of the polynyas in the North Water.

3509 STEFFEN, K. (1986)

Ice Conditions of an Arctic Polynya: North Water in Winter; J. of Glaciology, Vol. 32, No. 112. pp. 383-390.

3588 STEFFEN, K. (1987)

Fractures in Arctic winter pack ice (North Water, Northern Baffin Bay); Annals of Glaciology, Vol. 9, pp. 1-4.

Profiles of the ice cover in the North Water area were obtained in the winter of 1980/81 by using low-level infrared thermometry. The flight measurements were carried out from December to March. The statistical analysis of the sea ice surface temperature was carried out to yield distributions, frequencies and widths of fractures. Ice-free as well as ice-covered fractures with a maximum ice thickness of 0.4 m were analysed. Typical fracture frequencies were 0.25 per km for Lancaster Sound and 0.14 per km for Baffin Bay and the North Water area, with 90% of fractures being less than 0.6 km wide. From December to March, the fractures occupied 8.8% of the ice cover in the North Water area, 8.7% along the Baffin Bay profile and 10% in the Lancaster Sound. In the North Water area the distance (y) between fractures for different fracture widths (x) is an exponential function of the form $y=Ae^{xp}(ax)$ (A,a are constants), for fractures between 50 and 800 m wide. In the North Water area during winter, fractures of all widths occur 5 times more frequently than in M'Clure Strait and about 7 times more frequently than in southern Beaufort Sea. The heat loss in Lancaster Sound at the ice-air interface was found to be 40 to 100% larger due to the fractures compared to a fast ice situation in the same winter.

3589 STEFFEN, K., and OHMURA, A. (1985)

Heat exchange and surface conditions in North Water, Northern Baffin Bay; Annals of Glaciology, Vol. 6, pp. 178-181.

North Water is situated in the high Arctic between Greenland and Canada (74°-79°N, 70°-78°W). The sea surface of this region has no homogeneous ice cover during the winter and spring months, due to the occurrence of polynyas.

The results of the heat balance and the airborne remote sensing over North Water during winter are reported. The heat balance investigation was concerned with the identification of heat sources and their magnitudes. The remote sensing was aimed at determining the sea surface temperature and clarifying the exact nature of the surface of North Water in winter.

North Water was found to be mostly covered with new and young ice and probably devoid of first year ice until March. The surface was about 20°C warmer than that of the surrounding fast ice. The warmest areas were frequently located in Smith Sound, Lady Ann Strait and around the Carey Islands. Open water patches above freezing point, ranging from -1.5°C to -0.1°C were often found along the west coast of Greenland.

The surface of North Water receives heat from the sea water during winter between October and March at the rate of 15 $MJm^{-2}d^{-1}$ of which 80% and 20% are from enthalpy contained in sea water and latent heat of fusion released as the surface water freezes, respectively. The basic difference in winter heat balance between North Water and other ice covered arctic seas is the magnitude of the enthalpy supplied by the seawater which is 9 $MJm^{-2}d^{-1}$ larger for the North Water. This is the main heat source, which keeps the surface from becoming solidly frozen.

3125 THOMAS, V.G., and MacDONALD, S.D. (1987)

The Significance of Terrestrial and Marine Oases in the High Arctic; in Proc. Sym. on Arctic Heritage, eds. J.G. Nelson, R. Needham and Linda Norton, Aug. 24-28,1985, Banff, Alta., pp. 147-153.

3590 WILSON, J.R., and BAIRD, W.F. (1988)

An assessment of the state of knowledge of east coast offshore wave technology; Fish. & Oceans, Can. Tech. Rep. Hydrogr. Ocean Sci. No. 63, 158 p.

This report assesses the availability and adequacy of the wind generated wave data required by the oil and gas industry, including design organizations, owners or operators, classification societies, regulatory agencies and research organizations for the development, design, construction and operation of structures to be used in the activities of exploratory and delineation drilling in waters off the East Coast of Canada.

It is found that the minimum requirement of the design, owner, classification and regulatory organizations for wave data are well defined in the available literature and that if these data are available safe and efficient design of structures and associated operations are expected.

It is concluded that the required data are not available throughout the study area. Reliable estimates of the required extreme wave conditions

may only be available for the Hibernia area and even with these data there are some concerns. Throughout the remainder of the study area data suitable for the estimation of extreme events do not exist. Wave climate statistics suitable for the analysis of operations may exist for some locations in the southerly part of the study area, although limitations of these data are also identified. An important requirement identified, is the need for simultaneous observations or predictions of waves, currents and winds. It is not clear that this requirement has been adequately addressed over the study area. The availability of current and wind data is the subject of other reports and has not been examined here.

The future sources of wave data and information on extremes and wave climate are examined and conclusions are drawn. It is concluded that in the near future these data will continue to be developed using traditional techniques. However, improved advanced instrumentation and improved hindcast models better suited to the requirements of the various parts of the study area must be developed and implemented.

Satellite and other remotely sensed data will begin to become available within the next decade in useful quantities and will immediately begin to be useful for operations through improved forecasting. However, these additional data will not improve the knowledge of wave climate and extremes for a number of years until a significantly increased database has been accumulated.

The present practice of developing knowledge of wave climate and extreme conditions in the study area is examined. It is noted that this knowledge is now acquired by an accumulation of information from many independent studies which are generally of insufficient scope and not fully co-ordinated with other programs. These studies tend to raise more questions than they answer and often disagree with each other. It is concluded that there is a need to develop joint programs between all interested parties to organize, priorize and carry out the studies to acquire the necessary wave information in the study area.

3495 WINTERS, G.V., SYVITSKI, J.P.M., and MAILLET, L. (1985)

Distribution and dynamics of suspended particulate matter in Baffin Island fjords; Abstract in 14th Arctic Workshop, Arctic Land-sea interaction, Nov. 6-8, 1985, pp. 73-77.

OIL SPILLS

2989 DICKINS, D., MARTIN, L., BJERKELUND, I., POTTER, S., ERICKSON, D., HARPER, J., HORTON, P., JOHNSON, S., and VONK, P. (1987)

Environmental Atlas for Beaufort Sea Oil Spill Response; Env. Can., Environmental Protection Service, Yellowknife and Whitehorse, 235 p.

3110 SMYTH, K.E., BARRY, T.W., and DICKSON, D.L. (1986)

Key areas for birds in coastal regions of the Canadian Beaufort Sea, Env. Can., Can. Wildl. Serv., Edm., internal report 88 p.

SEA ICE

3498 CARSEY, F.D. (1985)

Summer Arctic Sea Ice Character From Satellite Microwave Data; J. Geophys. Res., Vol. 90, No. C3, pp. 5015-5034.

2989 DICKINS, D., MARTIN, L., BJERKELUND, I., POTTER, S., ERICKSON, D., HARPER, J., HORTON, P., JOHNSON, S., and VONK, P. (1987)

Environmental Atlas for Beaufort Sea Oil Spill Response; Env. Can., Environmental Protection Service, Yellowknife and Whitehorse, 235 p.

3591 FREDERKING, R.M.W., and TIMCO, G.W. (1984)

Compressive behavior of Beaufort sea ice under vertical and horizontal loading; in Proc. Third International Offshore Mechanics & Arctic Engineering Sym., Vol. III, pp. 145-149, DBR Paper No. 1192, NRCC 23324.

Field experiments on cylindrical and prismoidal specimens oriented in the plane of the ice cover and perpendicular to it are reported. Nominal strain rate was varied from 2×10^{-5} s^{-1} to 5×10^{-4} s^{-1}; both load and strain were monitored continuously. The strength of vertical specimens of unaligned columnar-grained ice was about three times that of horizontal specimens. Both orientations showed similar increase in strength with increasing strain rate. On the other hand, strain at yield for both specimen orientations was similar and showed no dependence on strain rate. Test system stiffness was measured and a technique for predicting strains is described. The measured uniaxial strength results are used to predict strength under the confined loading condition.

3592 FREDERKING, R.M.W., SAYED, M., WESSELS, E., CHILD, A.J., and BRADFORD, D. (1984)

Ice Interaction with Adams Island, winter 1982-83; in Proc. IAHR 7th International Sym. on Ice, August 27-31, 1984, Hamburg, W. Germany, Vol. III, pp. 187-201, DBR Paper No. 1295, NRCC 24682.

A small island (200 m in diameter) is being used to study the interaction of the ice cover with the island and the response of the ice cover to the environmental driving forces. The environmental factors of wind, air temperature, current and tide were measured. Horizontal movements of the ice cover varied from 10 cm per day in March to 2 cm per day in June. The direction of movement did not correspond to wind or current direction. Average strain rates measured with small (0.3 m) gauge length strain meters and large (~100 m) triangular arrays were of the order of 10^{-9} s^{-1}. Direct measurements of stress and values calculated from the strain rate were of the order of 100 kPa.

3593 FREDERKING, R., WESSELS, E., MAXWELL, J.B., PRINSENBERG, S., and SAYED, M. (1986)

Ice pressures and behaviour at Adams Island, winter 1983/1984; Can. J. Civ. Eng., Vol. 13, No. 2, pp. 140-149, IRC Paper No. 1379, NRCC 25950.

As a continuation of an ongoing project, measurements of environmental conditions and ice cover responses were made around Adams Island over the winter of 1983/1984. These included current, tide, speed and direction of wind, air temperature, and thickness, temperature, and salinity of the ice. Wind profiles were measured over the ice surface; from these, drag coefficients of 0.001-0.005 were calculated. Horizontal movement rates of the ice cover varied from 20 to 300 mm/day. No direct correlation was found between ice cover movement and the wind and current measurements. In situ ice pressures measured around the island averaged 250 kPa.

3594 HOLT, B., and DIGBY, S.A. (1985)

Processes and Imagery of First-Year Fast Sea Ice During the Melt Season; J. Geophys. Res., Vol. 90, No. C3, pp. 5045-5062.

An analysis of first-year fast sea ice during the melt season has been made by using surface measurements and aircraft radar and photographic imagery obtained during a field study near Prince Patrick Island in the Canadian Archipelago from June 13 to July 13, 1982, and satellite imagery from Landsat and Seasat. Distinct changes observed in the properties of the snow layer and the sea ice were a temporary increase in small-scale surface roughness caused by formation of nodules of ice at the snow/ice interface; extensive snow melt and surface flooding; development of surface water drainage networks and low topography around fractures and seal breathing holes; and a rapid draining of much of the surface water. From the extensive salinity profiles obtained, two zones of rapid desalination in the first-year ice were observed; one zone extending from the air/ice interface downward toward the center of the ice sheet that resulted from surface warming and drainage of the surface melt water through the ice and the other zone extending from the sea/ice interface upward toward the center of the ice sheet that resulted from heating and separation of seawater and ice caused by a layer of low-salinity meltwater beneath the ice formed from surface meltwater runoff. Aircraft radar imagery detected changes in the amount of surface water and in the development of topography surrounding drainage features. Similar changes were detected in coincident Landsat multispectral scanner (MSS) imagery of the study area and in SEASAT radar imagery and Landsat MSS imagery of the Prince of Wales Strait from July 1978.

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The growth, structure and disintegration of Arctic ice shelves; Polar Record, Vol. 23, No. 147, pp. 631-649.

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Arctic ice shelf growth, fiord oceanography and climate; Band, Vol. 20, Universitätsverlag Wagner, Innsbruck, pp. 147-153.

3574 JEFFRIES, M.O., SACKINGER, W.M., and SERSON, H.V. (1987)

Remote sensing of sea-ice growth and melt-pool evolution, Milne Ice Shelf, Ellesmere Island, Canada; Annals of Glaciology, Vol. 9, pp. 145-150.

3595 KING, L. (1981)

Sea ice conditions in the interior of the eastern Canadian Arctic Archipelago and their consequences for studies in the area of Oobloyah Bay, northern Ellesmere Island, N.W.T.,Canada; in Results of the Heidelberg Ellesmere Island Expedition, eds. D. Barsch and L. King, Univ. Heidelberg, Heidelberger Geographische Arbeiten, Vol. 69, pp. 521-539.

The development of sea ice in the interior of the eastern Queen Elizabeth Islands is portrayed by the analysis of Landsat imagery, aerial photography, data from the Sea Ice Atlas of Arctic Canada and other literature. The result is compared with own observations made during summer 1978. The development may be very different from year to year; years with low ice cover may be followed by years without break-up (e.g. 1972).

Oobloyah Bay may become free of ice when neighbouring bays and the greater fiords still didn't have their break-up. Due to the flight route this fact usually escaped discovery by the reconnaissance flights and is not displayed in the Sea Ice Atlas. This open water in Oobloyah Bay is caused by the great amount of relatively warm water from a large catchment area. In summer 1978 an average development was observed.

Ice push ridges along the shores of Oobloyah Bay are rare, comparatively small and rarely reach higher than 1 m a.s.l. Because of the long lasting ice cover, the bay is also a low energy environment for waves, that form the shore up to 50 cm a.s.l. A difference of 20 cm between high and low water has been recorded. Grounding icebergs probably from Otto Glacier have been registered at the presumably shallow entrance to Oobloyah Bay ahead of the delta of Etukashoo River. Driftwood may reach our area through Nansen Sound, as the ice barrier there, although recorded as very thick, may break in warm summers (e.g. 1971).

3584 LANGLEBEN, M.P. (1985)

Oceanic heat flux as a component of the heat budget of sea ice; Annals of Glaciology, Vol. 6, pp. 171-173.

3596 LANGLEBEN, M.P. (1985)

Some Statistics on Variability of Salinity of Sea-Ice in Eclipse Sound and on the Uncertainty in Measurements of its Temperature; Polar Cont. Shelf Proj., internal report 85 p.

Synoptic observations of the temperature and salinity of sea ice in Eclipse Sound near Pond Inlet, N.W.T. have been recorded by personnel from the Arctic Research Establishment for over a decade. The information contained in this report may be of assistance to potential users of this bank of data in that it provides a quick overview of the range of variation in temperature and salinity of the sea. The report is not a scientific report and no inferences are drawn from the statistical data presented, since these obviously would depend on the intended use of the sea ice data. For example, what might be considered a large variation in salinity in one study could possibly be neglected in another context.

3597 LANGLEBEN, M.P. (1986)

On the thermal diffusivity of sea ice; in Proc. International Assoc. for Hydraulic Research on Ice, August 18-22, 1986, Institute of Hydraulic Research, University of Iowa, Iowa City, U.S.A., pp. 567-578.

Time series measurements of sea ice temperature, made at one-hour intervals at the upper ice surface and at a depth of 25 cm, are used to determine the thermal diffusivity of sea ice by studying the vertical propagation of surface temperature transients through the ice. Theoretical propagation times, based on a solution by Carslaw and Jaeger of the one-dimensional heat diffusion equation in which thermal diffusivity is a parameter, are calculated. The calculations are repeated after making systematic change in thermal diffusivity until the theoretical propagation time is brought into coincidence with the observed propagation time for the temperature transient. The thermal diffusivity obtained in this fashion exhibits the expected temperature dependence and compares favorably with values determined by others using different methods.

3598 A.M. LOUNT AND ASSOCIATES (1961)

Preliminary feasibility report on the measurement of drift of the Arctic sea ice; Polar Cont. Shelf. Proj., internal report, 69 p.

In November 1960 we were charged with the task of preparing a feasibility study for the development of a method of measuring the rate and path of drifting ice in relation to: (a) a known point or points on shore; (b) on the ocean surface; and (c) on the ocean bottom.

3599 PARSONS, B.L., SNELLEN, J.B., and HILL, B. (1986)

Physical modeling and the fracture toughness of sea ice; in Proc. Sym. Offshore Mechanics & Arctic Engineering OMAE, April 13-17, 1986, Tokyo, Japan, pp. 358-364.

This work attempts to reveal the influence of temperature and microstructure on the fracture toughness of natural sea ice. Tests were performed on the ice in the temperature range -25°C to -8°C and specimen orientation was varied to determine the influence of a preferred c-axis orientation.

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Preliminary measurements of terminal crack velocity in ice; Cold Regions Sci. & Tech., Vol. 13, pp. 233-238.

Direct measurements of ice crack velocity obtained from double cantilever beam fracture toughness specimens gave a terminal velocity of approximately 20 m/s or $0.01C_d$ ($0.005C_s$) where C_d is the dilatational wave velocity and C_s the shear wave velocity. This value is much lower than both theoretical predictions, and experimental values obtained in other brittle materials, of approximately $0.3\ C_d$. It is shown that this low velocity is due to the low hardness of ice compared to glasses. Crack bifurcation was not observed in any of the samples and this is explained by the low crack velocity - in other materials bifurcation only occurs at high velocities. It is

concluded that fragment size in ice is, therefore, not the result of bifurcation, but rather a consequence of the various stress fields developed.

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Arctic ice island and sea ice movements and mechanical properties; Univ. Alaska, Fifth Quarterly Report, October 1-December 31, 1984, submitted to U.S. Dept. of Energy, 63 p.

3601 SAYED, M., and FREDERKING, R. (1986)

On modelling of ice ridge formation; in Proc. IAHR Ice Sym., August 18-22, 1986, Iowa City, Iowa, U.S.A., Vol. 1, pp. 603-614, IRC Paper No. 1426, NRCC 26718.

A review and comparison of calculation methods of ice ridging forces is presented. An overview of a new ridging model that predicts the limiting rubble height and depth is included. This model uses a diffusion equation to describe the normal stress spread in the bulk rubble. Results of calculation methods are compared to those of laboratory tests and a typical field situation. Continuum models appear to predict reasonable ridging forces while the potential energy method greatly underestimates the forces.

3602 SAYED, M., FREDERKING, R.M.W., and BRADFORD, D. (1986)

Ice cover deformations at Adams Island, winter 1982-83; Can. Geotech. J., Vol. 23, No. 3, pp. 346-354, IRC Paper No. 1420, NRCC 26644.

Measurements of horizontal movements of the ice cover near Adams Island, March to June 1983, and in Eclipse Sound, December 1982 to June 1983, indicate no apparent coupling between movement direction and wind or current. Average strain rates in the plane of the ice cover were 10^{-10} s^{-1}, with a maximum of 10^{-8} s^{-1}. Similar strain rate values were obtained on Eclipse Sound. Movement rates at Eclipse Sound were of the same magnitude as those at Adams Island, but the direction was quite different. Maximum calculated and measured ice pressures were 500 and 140 kPa, respectively.

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Uniaxial compressive strength of first-year and multi-year sea ice; Can. J. Civ. Eng., Vol. 11, pp. 82-91, DBR Paper No. 1180, NRCC 23260.

Strain-rate and stress-rate sensitivity of the compressive strength of first-year columnar-grained ice, first-year congealed frazil ice, and columnar-grained ice from an old floe have been investigated with load applied in the horizontal plane. In spite of similar salinity and density, the frazil ice proved to be considerably stronger than the columnar-grained ice. The strength of porous old floe ice with columnar-grained structure was very much the same as that of first-year ice of similar structure, but the clear bulk ice of the old floe was strongest. Rate sensitivity of strength for the three types of saline ice was similar to that of fresh-water ice. Ductility of the old clear ice (as measured by the strain at upper yield) was the same as that of fresh-water ice; ductility of porous old ice was comparable to that of new frazil ice. New columnar-grained ice proved to be the most ductile material.

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Acoustic Emission Study on Multi-Year Sea Ice in an Arctic Field Laboratory; J. Acoustic Emission, Vol. 4, No. 2/3, pp. S290-S293, IRC Paper No. 1349, NRC 25333.

Most working temperatures in ice are very close to its melting point. The behaviour of polycrystalline ice at these high homologous temperatures is viscoelastic, like metals and alloys at elevated temperatures, and exhibits high temperature embrittlement. The transparency of ice and the usually large grain size facilitate direct visual observation of the formation of microcracks. These properties make ice an attractive material for study of the failure process in conjunction with the measurements of acoustic emission (1). The present work was carried out in the field in March, 1984, during the uniaxial compressive strength testing of freshly sampled old sea ice.

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Young Arctic frazil sea ice: field and laboratory strength tests; J. Materials Sci., Vol. 21, pp. 1533-1546, IRC Paper No. 1381, NRCC 25985.

Methods of conducting and analysing uniaxial compressive strength and deformation measurements in the field and in the laboratory by means of conventional and closed-loop controlled test machines, respectively, are described, plus procedures for sampling, shipping, storing specimens and microstructural studies. Reliable measurements of the rate sensitivity of strength and deformation modulus of young congealed frazil sea ice can be obtained irrespective of location. Observations of Poisson's ratio, its variation during the tests, and its dependence on rate of loading are discussed.

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Ice Conditions of an Arctic Polynya: North Water in Winter; J. of Glaciology, Vol. 32, No. 112. pp. 383-390.

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Fractures in Arctic winter pack ice (North Water, Northern Baffin Bay); Annals of Glaciology, Vol. 9, pp. 1-4.

3589 STEFFEN, K., and OHMURA, A. (1985)

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Maps, geographical names and discovery of Borup Fiord and surroundings, northern Ellesmere Island, N.W.T., Canada, in Results of Heidelberg Ellesmere Island Expedition, eds. D. Barsch and L. King, Univ. Heidelberg, Heidelberger Geographische Arbeiten, Vol. 69, pp. 15-33.

2708 LEHN, W.H. (1983)

Temperature Profiles Computed from Superior Mirage Observations, Technical Digest (Meteorological Optics), Optical Soc. of America, Winter '83 Meeting, January 12-14, pp. FC1: 1-4.

The superior mirage is seen under conditions of temperature inversion. If the vertical atmospheric temperature profile is known, the computer simulation of such observations is relatively straightforward; but in most cases the necessary information is not available. However, with suitable assumptions, this distribution can be deduced from the mirage of a known object.

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